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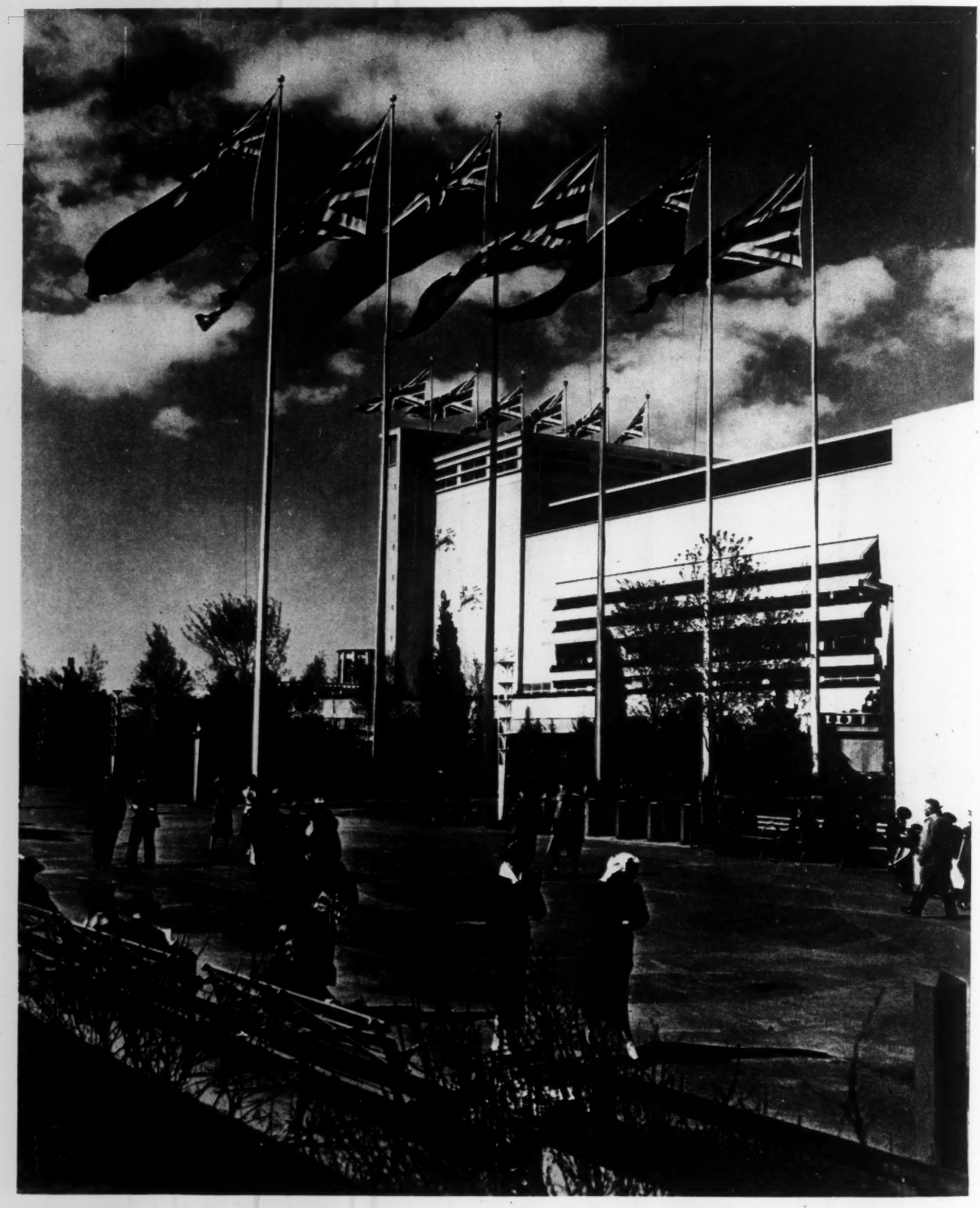

The British Pavilion—Shrine of the Magna Charta, New York World's Fair

(Institution of Mechanical Engineers of Great Britain to Meet with A.S.M.E. in New York, Sept. 4–8. *See pages 541 and 563 of this issue.**)*

VOLUME 61
No. 7

MECHANICAL ENGINEERING

JULY
1939

GEORGE A. STETSON, *Editor*

Preprint and Publication

THREE meetings within thirty days—that of the Applied Mechanics Division at Columbia University, New York City, June 14–15, of the Oil and Gas Power Division at the University of Michigan, Ann Arbor, Mich., June 19–22, and the Semi-Annual Meeting of the Society at San Francisco, Calif., July 10–14—offer an opportunity to explain how The American Society of Mechanical Engineers, under a handicap of limited funds, provides preprints of technical papers and how these papers are published.

First, for the record of service to members: The program of the Applied Mechanics meeting lists 13 technical papers; 11, all that have been received, were preprinted for the *Journal of Applied Mechanics* for distribution before and at the meeting. There are 14 papers on the Oil and Gas Power Division program. Of these 2 have appeared in MECHANICAL ENGINEERING, 4 have been set in type for Transactions, and 7 have been mimeographed. Copies of all of these were available at Ann Arbor upon payment of a fee of one dollar, which entitles the purchaser to another set at a later date when discussion has been prepared. No manuscript is available as yet for the other paper on this program. Of the papers for the Semi-Annual Meeting 6 have been published, or will soon be published, in MECHANICAL ENGINEERING, 9 have been preprinted for the Transactions, and 3 have been mimeographed. Manuscripts of the others have not as yet been released to the editorial department. Distribution of these preprints, gratis, by mail to those who order them is now going on and copies will be available at San Francisco. Eventually, all the papers presented at these three meetings and preprinted for the Transactions and the *Journal of Applied Mechanics* will be published, with discussion, in those periodicals.

The point to be emphasized is that an earnest effort is being made, in the face of limited publication funds, to provide members of the Society with preprints of technical papers, and to publish the papers with discussion for distribution to all members as quickly as possible. This is a three-feature service. By making special request, a member may receive, gratis, a preprint of any paper that is available. Every member eventually receives all papers published in Transactions, including the *Journal of Applied Mechanics*, or MECHANICAL ENGINEERING, subscriptions to which are part of the yearly dues. Any member desiring to pay an extra $10 may receive a bound copy of the year's Transactions which contains the technical papers and the discussions thereon.

The foregoing brief résumé of the Society's preprint and publication procedure should make it clear why the paper-sponsoring agencies—the professional divisions and the technical committees—attempt to make authors comply with the rule that all manuscripts must be in the committee's hands 90 days before the date of presentation. Review by the sponsors, possible revision as a result of review, editing, printing, and preliminary distribution of preprints take time. Moreover, when the total number of papers offered to the Society is considered, it becomes evident why these sponsoring groups have to set up rules to request that, where practicable, manuscripts be limited to 4000 words, that individual discussions be limited to 500 words, that the total discussion on any paper be limited to 4000 words, and that a symposium and the discussion on it be allotted, for publication purposes, no more space than would be allotted to two papers—8000 words of published material for the papers comprising the symposium and 8000 for the published discussion.

The British Visit Us

THE VISIT of their Majesties to this country serves as an auspicious prelude to the visit several hundred of their subjects, who represent the engineering profession, plan to make in September to take part in a joint meeting, in New York, of The Institution of Mechanical Engineers and The American Society of Mechanical Engineers. Wherever the Royal couple have appeared they have captured the hearts of admiring crowds as much, perhaps, by the graciousness of their manner as by virtue of what they represent to democratic people.

It should be one of the essential characteristics of the truly democratic mind that it recognize and correctly evaluate the essential qualities of ideas, institutions, persons, attainments, and modes of life regardless of origins and environments. Men with honest intellects and sincere purposes can always learn from one another, and the opportunity for personal acquaintanceship makes for understanding and mutual esteem and enriches those who experience it. The welcome that their Majesties received in this country was no warmer than that which will greet the British engineers.

To carry out the purpose of mutual benefit and interchange of ideas and practices, the committee in charge of program for the A.S.M.E. Fall Meeting, in which the I.M.E. will also participate, is concentrating attention on four aspects of the important subject of transportation. Four sets of papers and collateral discussions will

deal with railroad, marine, automobile, and aeronautical transportation. On each of these four subjects a British and an American engineer will present a formal paper reflecting conditions and practices in Great Britain and the United States. So broad are these subjects that every engineer is likely to find portions at least that touch his own interests vitally.

Opportunity to visit the New York World's Fair in connection with the September meeting will prove an educational and stimulating experience for the engineers of both countries. Preoccupation with his own affairs is likely to blind a man to what is going on around him. A holiday at the I.M.E.-A.S.M.E. meeting and the Fair will prove a partial cure for such involuntary blindness. Because of it a man's own problems will be seen in clearer perspective—a thought which Kipling expressed, and one particularly appropriate for this occasion, in the verse, "What do they know of England, who only England know?"

No Monopoly of Brains

ATTEMPTS on the part of presumably well-intentioned persons to modify patent law and procedure demand thoughtful consideration by engineers whose relationship to the system, however governed and administered, is especially vital. At the present time much discussion for and against change is heard. Because engineers wish to guard against unwise tampering with the system, factual evidence of how it has been functioning, based on the testimony of persons who have had experience with it, is needed. Last month a questionnaire, sponsored by the American Engineering Council, the National Association of Manufacturers, and the National Industrial Conference Board, was published on pages 483 and 484 of the *A.S.M.E. News* section of this magazine, and all readers who hold patents were urged to answer the questions asked as a contribution to the collection of the desired data.

In an address presented under the auspices of the Federal Bar Association of New York, New Jersey, and Connecticut, Charles E. Lucke discussed certain aspects of the subject "Engineering and Patents." Professor Lucke's address will be found on pages 531 and 532 of this issue. One point stressed by him will appeal to many engineers and is likely not to be considered by those to whom monopoly in any form is abhorrent. Professor Lucke presents an argument against compulsory licensing on the grounds that it "amounts to nothing more than legalization of copying by competitors, even if a royalty is paid, and in effect so devalues the patent as to make its issue an idle act, and a useless expense. The competitor should be forced to develop his own improvements by engaging competent engineers. . . . Thus the case will be; no patent protection, no improvement; adequate patent protection of a first improvement, then a second, a third, and a whole series of improvements." Viewed in this light, the apparent monopoly becomes the stimulus to competition and progress, because there is no monopoly of brains.

Good Engineering Also Necessary

CONTROVERSY over the vital problem of putting ten million unemployed back into useful work in private enterprise has waged for years without conspicuous results in so far as any large-scale reemployment is concerned. The government spending policy has been extensively tried, supplemented by loans, large and small, through such agencies as the Reconstruction Finance Corporation and the Home Owners Loan Corporation, to mention but two of the best known of several federal lending organizations. At present attention is focused on proposals to provide long-term capital credit for small and medium-sized business concerns, as embodied in the Mead bill, and in the suggestions put forward by Assistant Secretary of State Berle, Chairman Frank of the Securities and Exchange Commission, Chairman Eccles of the Federal Reserve Board, and others.

It is not intended at this time to contribute to the controversy by a discussion of the merits of these proposals, their economic and fiscal soundness, or the effects their adoption would have upon the future of private enterprise. It is rather the intention to take what may be a much narrower view and to point out the fact that in any liberalization of credit to small businessmen according to the patterns suggested, common prudence would dictate employment of many engineers in certain of the industries benefited as a guarantee of their successful operation.

This thought is prompted by a comment by William H. Pouch, president of the Concrete Steel Company and chairman of the advisory committee on loans of the Federal Reserve Bank of the New York district. Mr. Pouch's plea was for outside management counsel and instruction in accounting procedure for the enterprises to which the proposed loans would be made. He is reported to have said that it had been his experience that a majority of companies to whom loans had been refused under present procedure had totally inadequate bookkeeping so that it was impossible to determine whether they had ever earned any money. This is a vital consideration, of course, and were Mr. Pouch's suggestion to be adopted, many engineers could be found with sound training in management and accounting procedures who could serve in the consulting capacity proposed.

Moreover, Mr. Pouch's suggestion can logically be extended to cover assurance of competency in technological as well as accountancy fields. As was pointed out on this page last month, the growth of applied science and technology in business enterprises is increasing so that many nonengineered plants would profit by employing the services of engineers. Surely if there is to be a federal guarantee of loans to small and medium-sized businesses, provision should be made for insuring that the borrowers engaged in enterprises related to technological fields utilize the services of men trained and experienced in engineering. By their record of achievement engineers have shown that they are able to provide the technical knowledge that is essential for the success of enterprises in industrial fields.

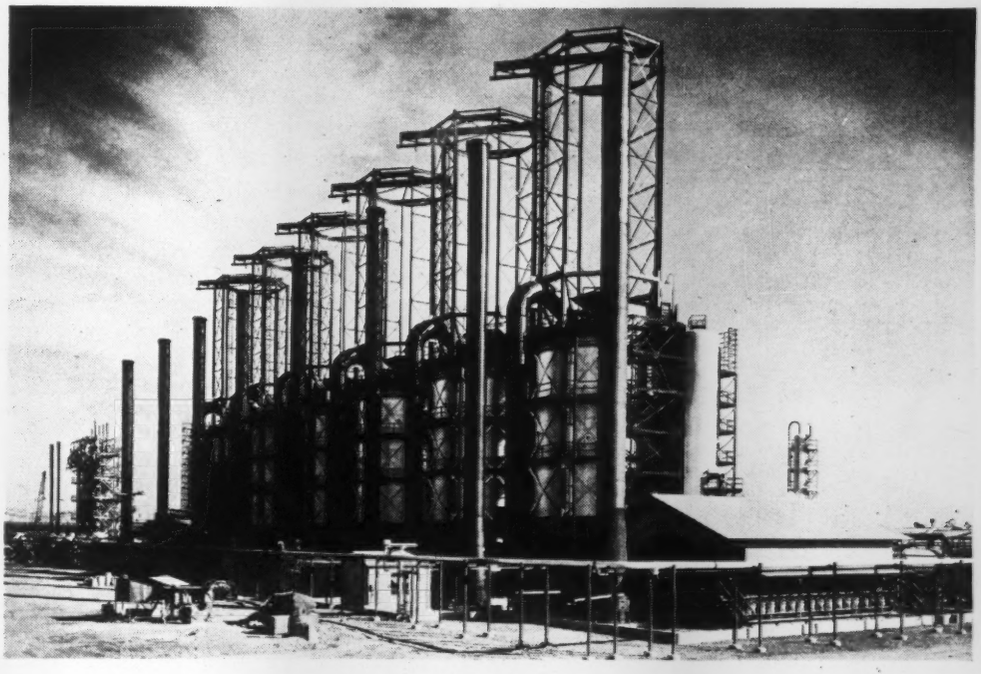

FIG. 1 VIEW OF FURNACES OF COMBINATION UNITS

Design and Operation of DE FLOREZ FURNACES

By GEORGE C. LESLIE

COMBUSTION ENGINEER, WATSON REFINERY, WILMINGTON, CALIF.

THE PURPOSES of this paper are to review past designs of oil-still furnaces and to describe briefly the design and operation of the latest type De Florez furnaces used in the new combination topping-and-cracking units, Fig. 1, at the Watson Refinery of the Richfield Oil Corporation. These furnaces are among the largest of this type ever built. The six furnaces, Fig. 1, contain a total of 41,000 linear ft of alloy tubing, 800,000 bricks, 1200 tons of structural steel, and are 135 ft high to the top of the superstructure.

The two units served by these furnaces have a combined capacity of 50,000 bbl per day of crude and reduced crude, the proportions of which may be varied over a wide range.

EVOLUTION OF FURNACES

Before proceeding to discuss the various features incorporated in the design of these furnaces, it may be pertinent to indicate some of the more important changes that have been made in furnace design leading to the highly efficient equipment in use today. It will be shown that the trend has been toward the use of more radiant-heat-absorbing surface, larger average transfer rates, milder furnace conditions, and less excess air, culminating in the De Florez furnaces to be described.

The type of pipe still which first came into general use is shown in Fig. 2. In furnaces of this type, there is a great variation in heat input between the top and bottom rows of tubes. The heat transfer to the bottom row may be as much as 20,000 to 25,000 Btu per sq ft per hr, while the top row may be absorbing only 300 to 400 Btu per sq ft per hr. The high input in the bottom row is due to its receiving heat by both radiation and convection. To operate furnaces of this type, it is necessary to use large amounts of excess air in order to maintain low furnace temperatures. Ordinarily, the feed enters at the top and leaves at the bottom. In some installations, however, in order to increase the life of the bottom row of tubes, the flow was arranged so that the oil, after passing through one or two rows at the bottom was conducted to the top row and then downward through the remaining tubes.

In an endeavor to protect the bottom row from excess heat absorption and against any possibility of direct contact with the flame, the next step was to locate the tube bank behind a bridge wall as in Fig. 3. This construction gave a much better distribution of the hot gases over the tubes and accomplished the purpose of protecting the tubes from direct contact with the flame. However, there being no heat-absorbing surface in the furnace, the furnace temperatures became excessive and radiation from the furnace roof resulted in the burning out of the top tubes of the convection bank. A large amount of excess air was still required and variation in transfer rate was still very

Contributed by the Fuels Division for presentation at the Semi-Annual Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, to be held at San Francisco, Calif., July 10–15, 1939.

great. To secure higher efficiencies, recirculation of flue gas or air preheat or both were used.

At about this stage of the development, furnaces with roof tubes began to appear, Fig. 4. In some designs, that portion of the tubes located directly over the furnace was protected by be-

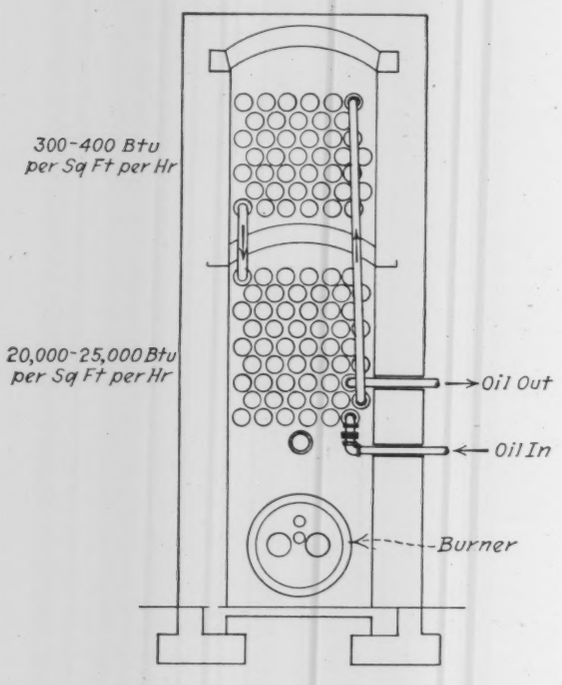

FIG. 2 SIMPLE PIPE STILL

ing encased in firebrick and the portion over the convection bank was encased with cast iron to prevent reradiation into the convection bank. However, with only one row of roof tubes, and that encased in this manner, very little heat was absorbed from the furnace, and the amount of excess air required was still large.

When a large air excess is used to lower the temperature in the radiant section, a greater amount of work must be done in the convection bank. The large volume of hot gases makes the stack temperatures an important factor and, since in most cases it is not economical to lower the stack temperature to less than 200 to 300 deg above that of the incoming oil, which may be 500 to 600 F in a cracking plant, the resulting stack temperature will be 700 to 900 F. A considerable portion of this heat can be recovered by the use of an air preheater.

In a recirculating furnace, 50 to 75 per cent of the hot gases leaving the heater are returned to the furnace to lower the furnace temperature in the same way as does excess air. At the same time this cuts down the weight of hot gases escaping to the stack.

The next step was probably the most important in the evolution of the modern furnace. Designers had begun to realize that, in order to have a low temperature entering the convection bank, more heat would have to be absorbed in the furnace. This was accomplished by the addition of more rows of roof tubes, together with wall tubes as shown in Fig. 5. In some designs, this was done by the addition of floor tubes. Tubes located in the radiant section absorb two or three times as much heat per square foot as those located in the convection bank. By increasing the amount of radiant-heat-absorbing surface, the temperature of the hot gases entering the convection bank can be brought down as much as desired. The result is an increase of the total heat absorbed by radiation from 50 per cent in the early type of furnaces to nearly 80 per cent in the latest furnaces.

Fig. 6 shows a double-end-fired type of furnace. It consists essentially of two radiant sections with a common convection bank located between them. This type of construction also permits the use of large amounts of radiant-heat-absorbing surface.

EARLY DE FLOREZ FURNACES

In the design of his furnace, L. De Florez[1] commenced with the premise that the ideal furnace would be one "which would combine the ability to utilize to the fullest extent the radiant heat produced by burning of the fuel with the theoretical amount of air." His solution was a vertical cylindrical shell in which the tubes were symmetrically spaced around the inner wall. This design brought about "the elimination of the conventional brick-lined combustion space, to permit the absorption of heat to begin immediately after its generation." The principal variations in design since the original conception have been in the location of the burners and the method of recovering the available heat in the hot combustion gases before they enter the stack.

Many of the so-called "up-shot" type furnaces were built in which the burner was located at the bottom of the cylinder and the column of hot combustion gases traveled upward in the center of the cylinder. This type had the advantage that only a short stack was required which was located on the top of the upright cylindrical portion.

In the downdraft type, the burner is located at the top of the furnace and the hot products of combustion are discharged

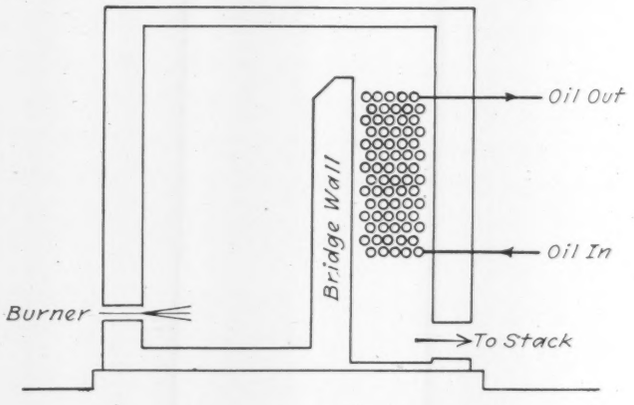

FIG. 3 PIPE-STILL FURNACE WITH BRIDGE WALL

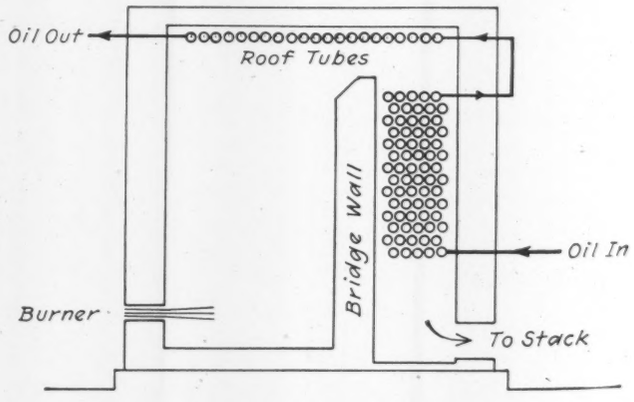

FIG. 4 PIPE-STILL FURNACE WITH BRIDGE WALL AND ROOF TUBES

[1] "Design New Type of Refinery Still," by L. De Florez, *Oil & Gas Journal*, May 2, 1929.

downward concentric with the tubes and shell. In both cases, the burners are located some distance back of the tube sheets to afford a short high-temperature section in which combustion is initiated.

Economizer sections and air preheaters have both been used to lower the temperature of the hot gases before they enter the stack. However, when the temperature of the feed entering the furnace is higher than the temperature to which the stack gases must be cooled in order to secure the desired furnace efficiency, it is evident that the addition of economizer coils, however large, will not give the required results. It is just as evident that, if the required stack temperature is to be attained, some medium at a sufficiently low temperature must be supplied in sufficient amounts to absorb this excess heat. This medium is the combustion air. The desired transfer can be accomplished either by means of the ordinary tubular preheater or a Ljungstrom preheater.

Even in those cases where the oil feed to the furnace is at a temperature sufficiently low to cool the stack gases to such a temperature as would give the required furnace efficiency, the surface required might be so large as to be uneconomical and the use of an air preheater justified. Every tube added to the oil flow increases the pressure drop through the coil and increases the pumping and maintenance costs.

DESCRIPTION OF DE FLOREZ FURNACES AT WATSON

The six furnaces at the Watson refinery are of the down-draft type and are equipped with a brick cone as shown in Fig.

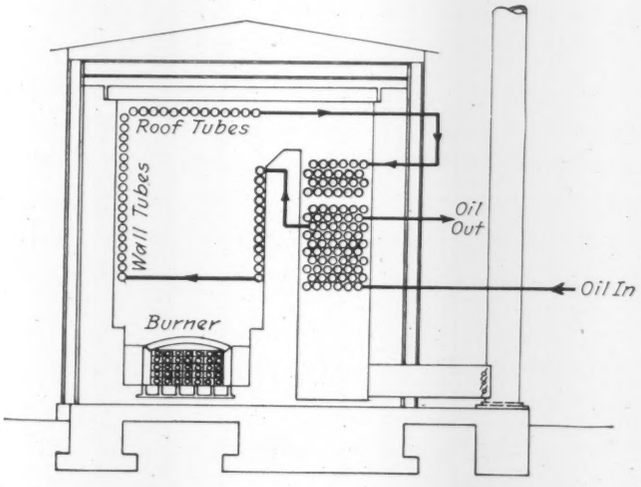

FIG. 5 PIPE-STILL FURNACE WITH WALL AND ROOF TUBES

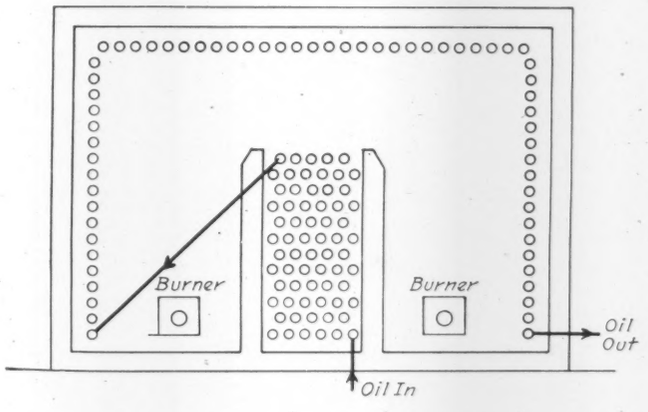

FIG. 6 DOUBLE-END-FIRED FURNACE

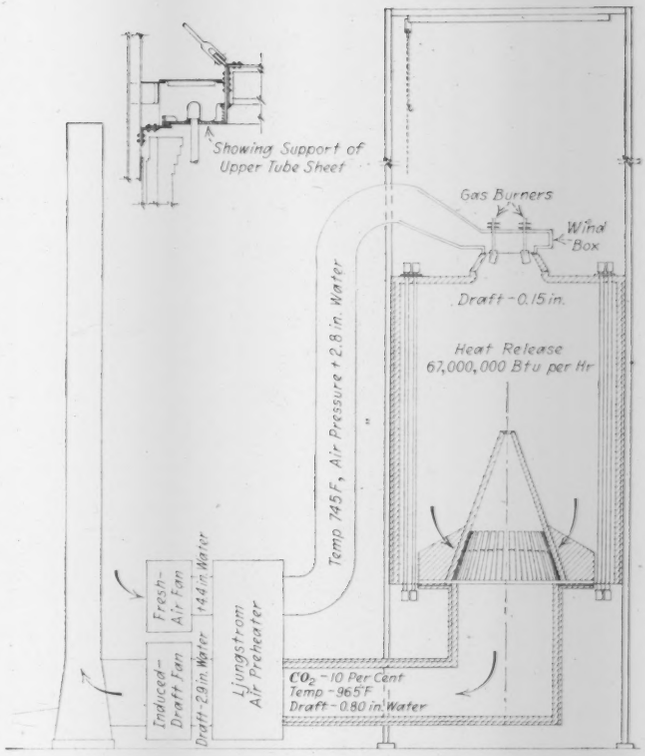
Showing Support of Upper Tube Sheet
Gas Burners
Wind Box
Draft - 0.15 in.
Heat Release 67,000,000 Btu per Hr
Temp 745 F, Air Pressure + 2.8 in. Water
Fresh-Air Fan
Induced-Draft Fan
Draft - 2.9 in. Water
Ljungstrom Air Preheater
CO_2 - 10 Per Cent
Temp - 965 F
Draft - 0.80 in. Water

FIG. 7 DE FLOREZ FURNACE

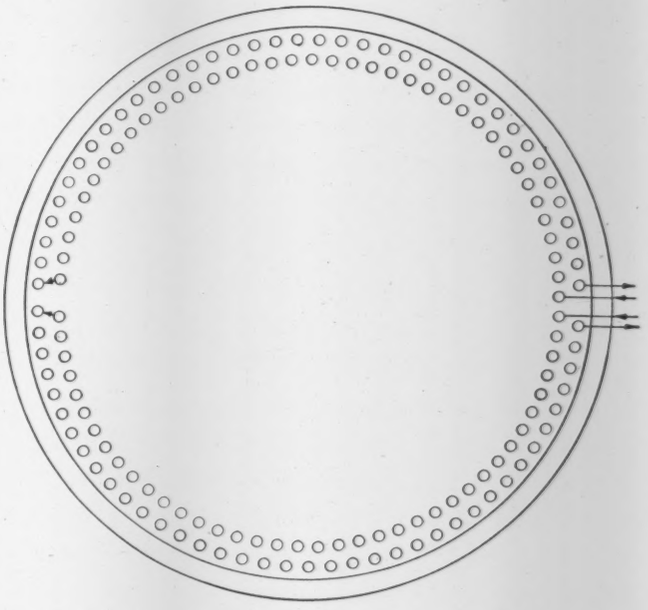

FIG. 8 TUBE LAYOUT OF DE FLOREZ FURNACE SHOWING FLOW OF OIL

7, which considerably improves the heat distribution as compared with previous models.

The internal diameter of the furnace, wall to wall, is 28 ft 9 in. Each furnace contains 152 tubes, 4 in. inside diameter, 5 in. outside diameter, and 45 ft long, arranged in two concentric circles. Each tube coil is composed of 76 tubes. In each coil, the charge travels through 38 tubes in the inner row, then through 38 tubes in the outer row.

The tubes are staggered and at such distances apart that, not only do all the tubes receive the direct radiation from the

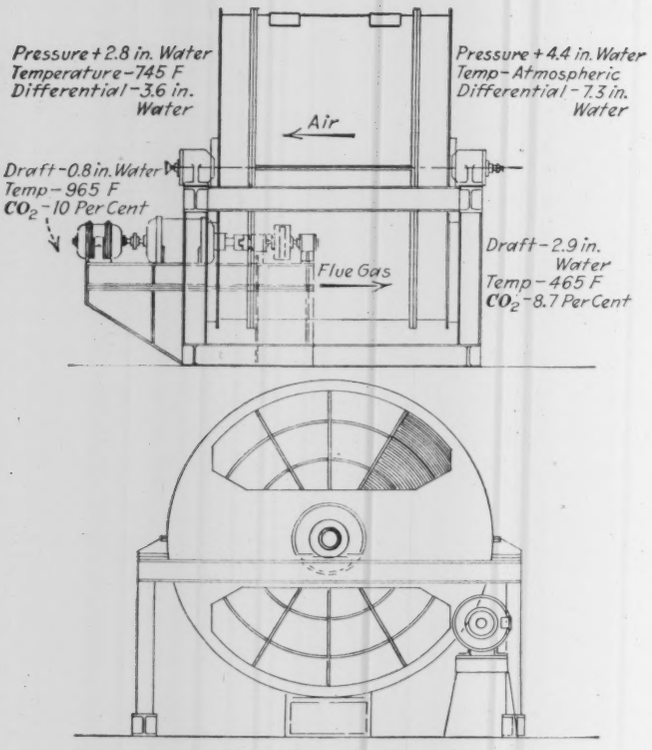
Pressure + 2.8 in. Water
Temperature - 745 F
Differential - 3.6 in. Water
Pressure + 4.4 in. Water
Temp - Atmospheric
Differential - 7.3 in. Water
Air
Draft - 0.8 in. Water
Temp - 965 F
CO_2 - 10 Per Cent
Flue Gas
Draft - 2.9 in. Water
Temp - 465 F
CO_2 - 8.7 Per Cent

FIG. 9 LJUNGSTROM AIR PREHEATER

column of hot combustion gases but, assuming a diameter of 12 ft for this column, all of the refractory wall is also receiving direct radiation. According to McAdams,[2] if there were no external loss of heat from the back wall, the latter must take up an equilibrium temperature between that of the tubes and that of the radiating plane, and must radiate back as much heat as it absorbed.

In the transfer of heat by convection, there always remains a comparatively stationary film of gas around the tubes through which the heat must be transferred by conduction, but which offers no resistance to the transfer of heat by radiation. To secure high rates of radiation, it is not necessary that the tubes be wiped with flue gas at comparatively high velocities and temperatures. The maximum temperature of the flue gas in contact with the tubes is approximately 1350 F, while the approximate average transfer rate is 7000 Btu per sq ft of outside surface per hr.

The furnace volume is 20,900 cu ft, of which 3500 cu ft are occupied by the cone, leaving a net furnace volume of 17,400 cu ft. The furnaces are designed for a normal liberation of 80,000,000 Btu per hr, which corresponds to 4600 Btu per cu ft per hr. Operating at this capacity, the throughput per coil would be approximately 20,000 gal per hr. However, to date the furnaces have only been required to operate at approximately 75 per cent of designed capacity.

Tube Supports. The tubes are supported by the top tube sheet which in turn is hung from the steel supporting structure. The distance between the tube plates is 43 ft 6 in. A particular advantage of this type of construction is that the tubes are suspended vertically and there is no tendency for them to sag. The position of the tubes also permits their being easily cleaned and removed. A superstructure is provided on each heater which carries an overhead trolley used in cleaning or replacing tubes.

[2] "Heat Transmission," by W. H. McAdams, McGraw-Hill Book Company, Inc., New York, N. Y., 1933, p. 59.

Tube Cleaning. Five tubes are cleaned at a time by two men. A battery of five complete sets of cleaning apparatus is suspended from a manifold. The five air-driven tube cleaners are lowered into the tubes so that the cutters are just below the roll before the air is turned on. The turbines are then lowered as fast as desired. A stop is fastened to each hose to prevent the tube cleaner from going too far and striking the seat at the bottom. After cleaning the first five tubes, the battery of cleaners is moved to the next group. Any tube not thoroughly cleaned is cleaned individually.

Brickwork. The insulation and refractories were selected for the following approximate maximum-temperature conditions:

Roof-cone and nose temperature	2700 F
Suspended-arch temperature	2200 F
Cover-tile temperature	1600 F
Radiant-cone temperature	1600 F
Side-wall (fire side) temperature	1000 F
Insulation (fire side) temperature	800 F

The side walls are at such a low temperature and the expansion and contraction are so uniform throughout, due to the shape of the furnace, that these walls will probably never need to be repaired. The burner throat is built of a plastic refractory and, up to the present time, there is no indication of cracks which might eventually require patching, although some maintenance is expected at this point. The roof between the burner throat and the tube sheet is of the suspended flat-arch type.

Inspection Ports. In all there are twenty-eight inspection ports on each furnace, through which all of the tubes can be carefully and readily inspected. Four are located in the roof through which the cone and bottom of the furnace can be inspected; twenty in the side walls, of which sixteen are about 10 ft below the roof; and four just below the top of the cone. To permit inspection of the burners and flame, four more ports are located in the furnace bottom. The ability to inspect all of the tubes is a great advantage.

Temperature Measurements. Two recording potentiometers are provided for each furnace. One records the temperatures of the oil, while the other records the furnace temperature, stack temperature, and the metal temperature of the hottest tube.

The so-called "furnace temperatures" are taken at four

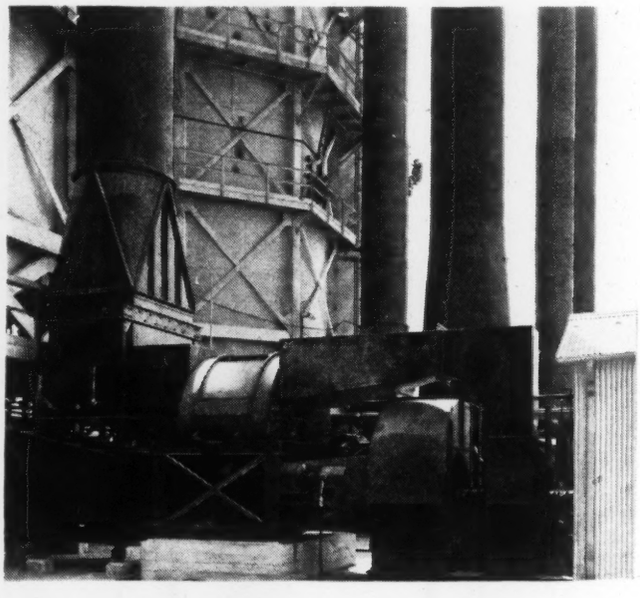

FIG. 10 FANS AND AIR PREHEATER

locations, at each of two different levels, by couples extending through the furnace walls to a point just beyond the inner row of tubes. In reality, the couples measure the temperature of the furnace gases coming in contact with the tubes. Sixteen tube-metal temperatures are taken every four hours from an indicating instrument. As all of the tubes are located next to the outside wall, thermocouples may readily be attached to any part of an individual tube.

The maximum allowable tube-wall temperature depends upon the operating pressure and is kept within the limits permitted by Lowe's formula.[3]

Air Infiltration. To prevent air infiltration, the joints between the segments of the upper tube sheet are carefully pointed with a mixture of asbestos cement and fire clay. The lower tube sheet is covered with 8 in. of a mixture consisting of four parts Sil-O-Cel and one part Portland cement. The draft is highest at the bottom furnace, and here the greatest care should be taken in sealing all cracks. The importance of stopping all possible air infiltration cannot be overemphasized.

The furnace shell is carefully inspected for leaks, especially around inspection ports, thermocouple connections, tube headers, and transfer lines. Cold air leaking in through the furnace walls cools the brickwork considerably and appreciably cuts down the radiation from it.

In filling the cracks in the roof, care must be taken to cover only the cracks between the bricks and not to cover the metal supports or cast hangers, which must be kept relatively cool to prevent failure. In addition to this, a slight draft must be maintained at the top of the furnace so that, if the roof is not gastight, the leakage will be inward rather than outward, preventing a severe temperature condition in the brickwork. A draft of 0.15 in. of water at the top of the furnace has been established as the minimum which can be carried with safety. Any considerable air leakage through the roof is made apparent by the cracks between the bricks appearing dark. With little or no air leakage, the cracks are barely distinguishable. Since the one outstanding advantage of this type of furnace is the ability to operate with very small amounts of excess air, it would be very uneconomical to permit this to be increased by air infiltration.

LJUNGSTROM AIR PREHEATER

No economizer coils are used, but the hot flue gases from each furnace are cooled by means of a Ljungstrom air preheater. This type of preheater recovers heat from the hot flue gases and uses it to preheat the combustion air. The heat added to the combustion air accomplishes as much useful work as though it were obtained from an additional equivalent amount of fuel.

The Ljungstrom air preheater is of the regenerative type, that is, it contains plates which alternately pass through the hot flue gas and the air to the burners, so that the heat absorbed from the hot flue gas in one part of the cycle is given up to the air in the other part of the cycle. It consists of a rotating member, Figs. 9 and 10, made of closely packed corrugated-metal elements. The elements on the hot end are made of 16 per cent chrome steel and those on the cold end of steel containing 4 to 6 per cent chromium and 0.5 per cent molybdenum. The hot flue gases flow through the lower half of the apparatus in one direction and the cold air through the top half in the other. The apparatus slowly revolves, the elements in the lower half becoming heated and moving slowly into the upper half, where they give up their heat to the combustion air. When operating at maximum designed capacity, each unit will heat 77,000 lb of air per hr from 60 F to 920 F, and cool 100,000 lb of flue gas from 1300 F to 690 F. The air leakage when the air preheater is in first-class condition amounts to 10 to 11 per cent.

GAS-AND-OIL BURNERS

In earlier installations, a single large burner was used. It was found, however, that the multiburner type gave better

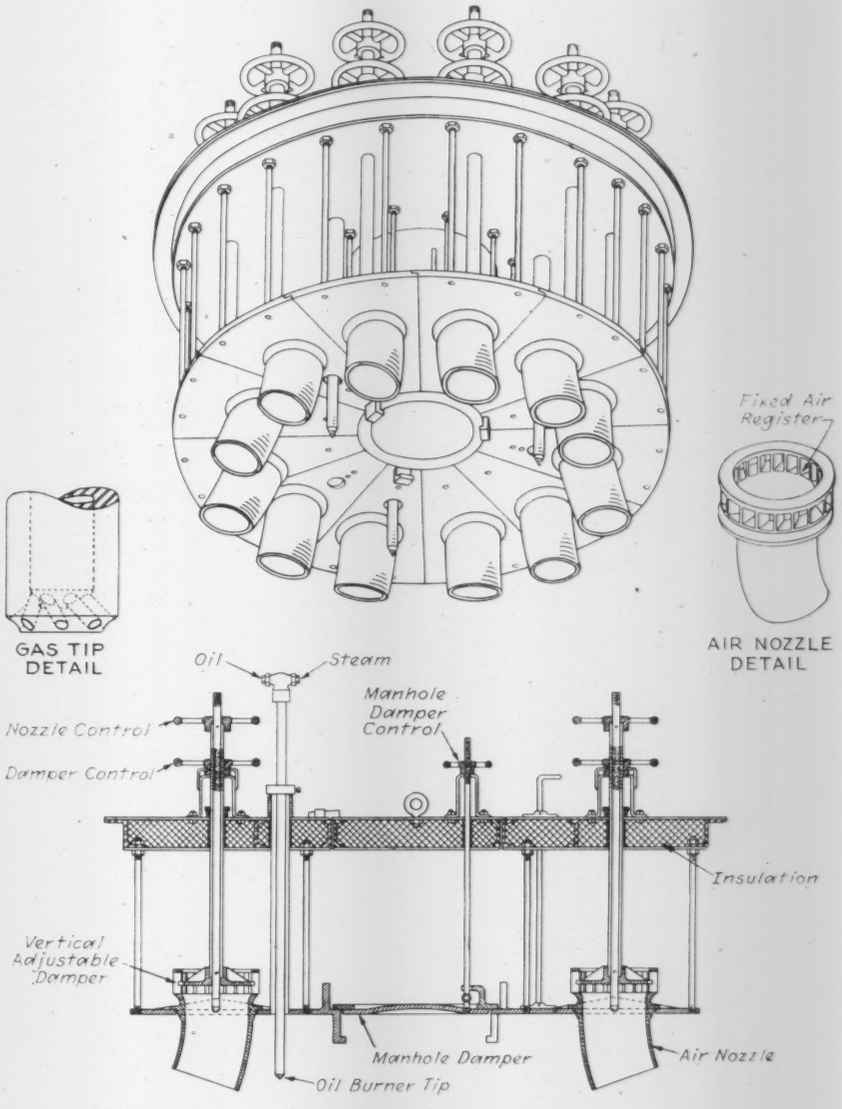

FIG. 11 COMBINATION OIL-AND-GAS BURNER

(Special alloy combination oil-and-gas burner, forced draft, hot air, twelve dampered fixed register air nozzles capable of 360 deg rotation, equipped with special drilled nonpremix gas burner tips, three steam atomizing internal-mix oil burners with drilled cone tips, adjustable center manhole for secondary air control.)

[3] National Tube Company, Bulletin No. 20.

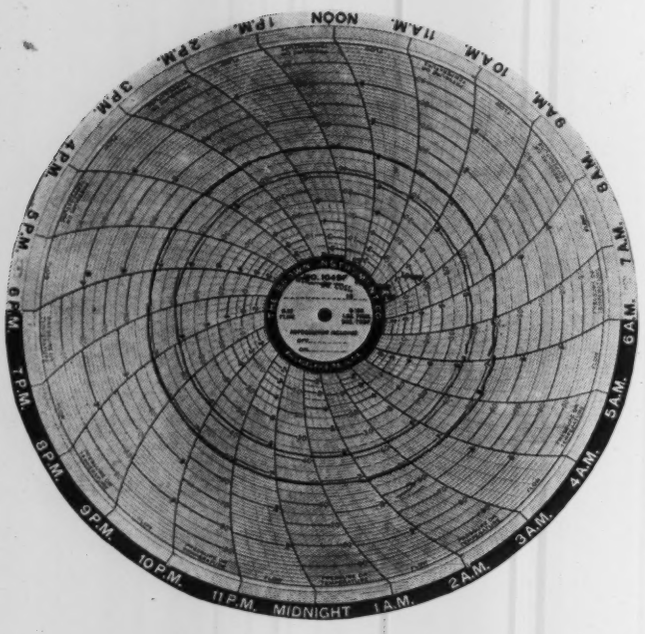

FIG. 12 OIL FLOW THROUGH ONE COIL

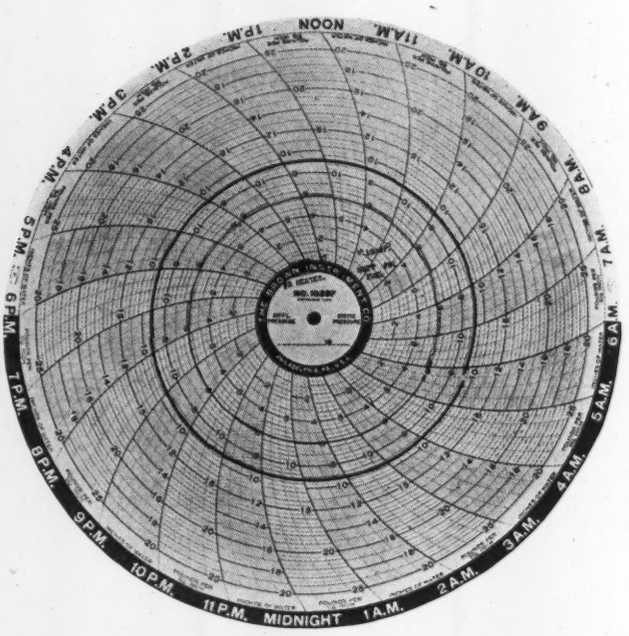

FIG. 14 FUEL-GAS-FLOW CHART

results. It not only permitted better heat control within the furnace, but the larger diameter of the column of hot gases enabled it to be seen by larger areas of the tube and wall.

The present installation consists of twelve individual gas burners, each with its own air and gas supply, Fig. 11. Campbell[4] describes this burner as follows: "It was designed for use with 1100 F preheated air with a capacity of 100,000,000 Btu per hr. The gas-burning features consist of twelve curved alloy air tubes or nozzles inserted through and resting upon a twelve-section alloy bottom plate. Each air nozzle is equipped with a fixed air register, as shown in the air-nozzle detail, Fig. 11. The air supply to each nozzle is controlled by a circular damper inside of each register. This damper can be moved up or down by the damper-control wheel. The gas is delivered to the center of each air nozzle by means of a gas pipe inserted through the individual damper-control pipes. The air nozzle can be rotated by means of a nozzle-control wheel through an angle of 360 deg to obtain heat distribution to any part of the furnace. In the center of the bottom burner plate is a manhole damper, which can be raised or lowered as required for additional air supply and also for heat-distribution control. The manhole damper is suspended from three points and can be tilted for additional control of heat distribution. The oil-burning feature of this combination oil-and-gas burner consists of three internal-mixing, steam-atomizing oil burners equipped with drilled-cone tips. When burning fuel oil only, the air nozzles and manhole damper are adjusted to provide heat distribution. The main advantage of this type of combination oil-and-gas burner is heat-distribution control at high capacity. The burner is also able to operate at low capacity with low excess air and satisfactory heat distribution. The main disadvantages are: The gas tips become plugged when using dirty gas, and high wind-box and gas pressures are required." This type of burner has been in operation in another oil refinery for a period of approximately two years with substantially no maintenance.

CONTROL OF TRANSFER-LINE TEMPERATURES

The control of the temperature of the oil in the transfer line resolves itself into three problems: (1) The supplying of a constant flow of charging stock to the furnace; (2) the maintenance of a constant pressure in the fuel-gas lines; and (3) the regulation of the flow of the gas to the burners to compensate for variations in heating value of the gas, fluctuations in the temperature of heater feed, and any other irregularities. In other words, the first two factors are held constant, and the third factor is variable.

The 1000-hp motor-driven centrifugal pump maintains a constant discharge pressure on the charging stock to each unit, while the flow to each coil is controlled from the main

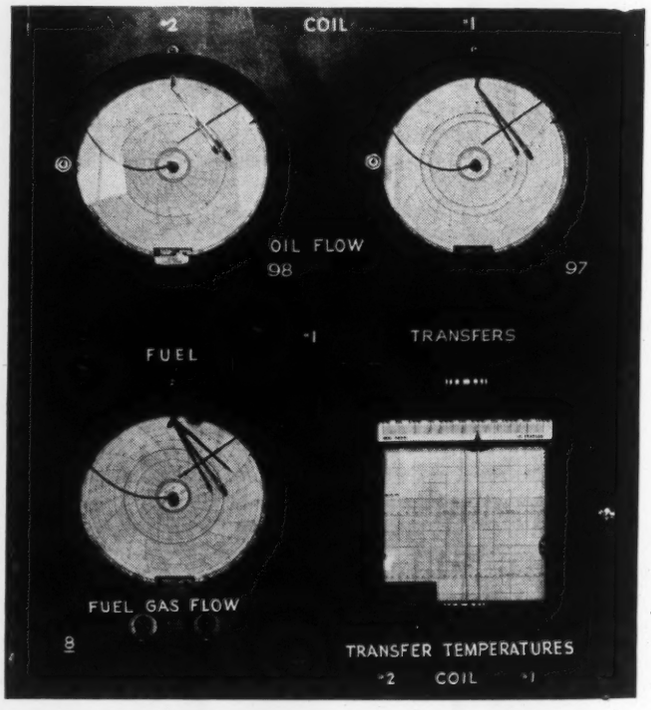

FIG. 15 CONTROL-PANEL SECTION

[4] "Combination Oil-and-Gas Burners," by O. F. Campbell, *Refiner and Natural Gasoline Manufacturer*, vol. 17, July, 1938, p. 315.

control board by manual adjustment of a remote-control, electric-operated valve.

The gas pressure to the fuel-gas manifold is maintained constant at 50 lb per sq in. by a back-pressure relief valve on the line through which the surplus gas produced is discharged into the refinery fuel-gas system. The fuel gas to the burners is controlled by adjusting the control point on a flow controller in which the ordinary device for adjusting the control point has been replaced by a pneumatic-transmitting unit which adds to the convenience and sensitivity of the instrument. The regulating valves on the fuel-gas lines to the burners are all equipped with valve positioners.

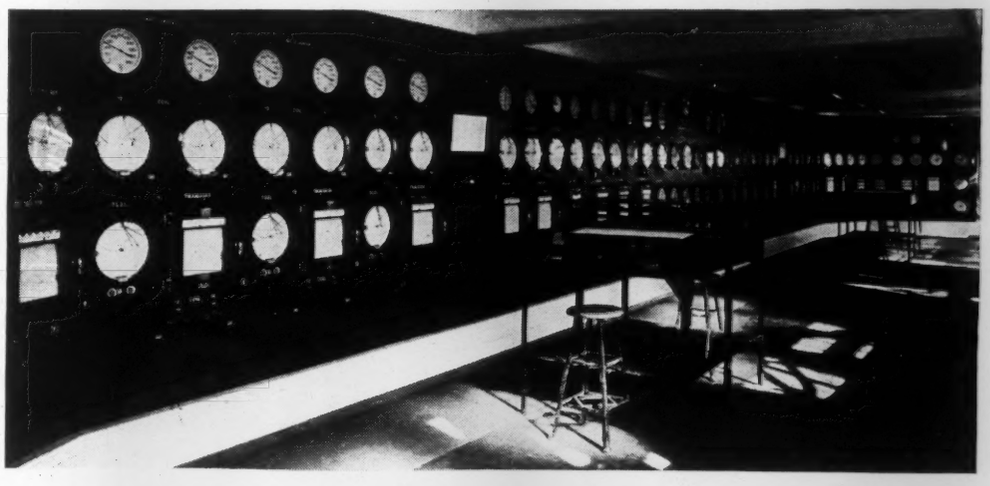

FIG. 16 CONTROL BOARD

Some idea as to the uniformity of control may be gained by studying Figs. 12, 13, and 14. Fig. 15 illustrates a group of furnace instruments and Fig. 16 shows the entire control board, which is 83 ft long and contains a total of 136 instruments.

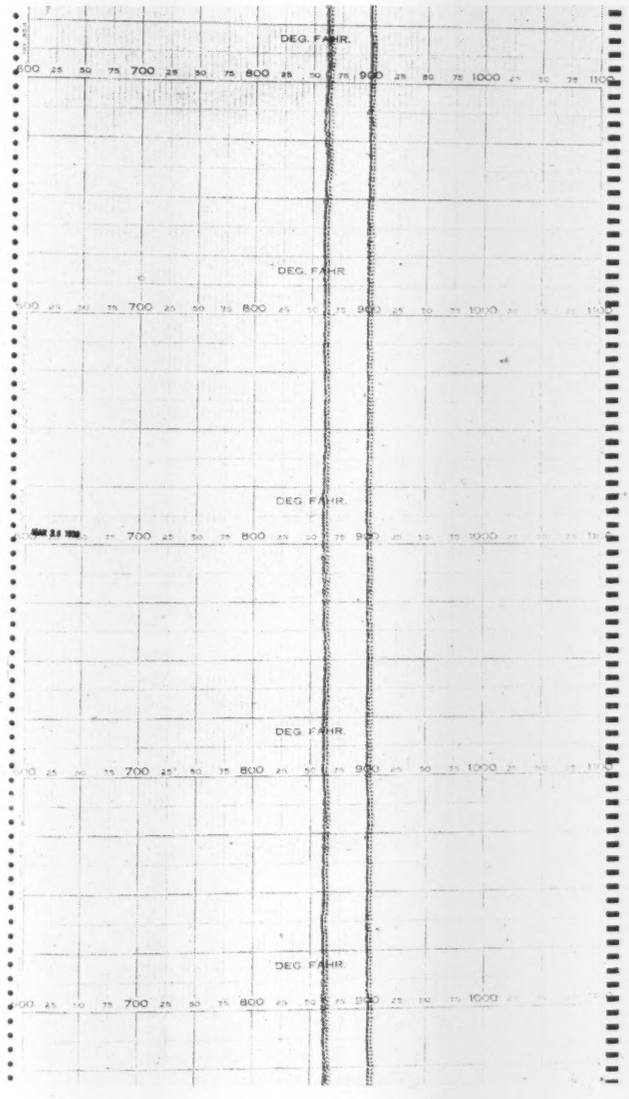

FIG. 13 OIL-TRANSFER TEMPERATURES

COMBUSTION CONTROL

With air infiltration at a minimum, the amount of excess air in the flue gas can be easily kept at 25 per cent, which corresponds to approximately 10 per cent carbon dioxide when burning refinery gas. An Orsat analysis of the flue gas from each heater is made each day to determine the percentages of carbon dioxide and oxygen from which the percentage of excess air is calculated.

To check the flue-gas analysis, the chart shown in Fig. 17 was constructed. All analyses of the flue gas of any given fuel if correct will lie on the same straight line. If extended, it will intersect the oxygen line at 20.9 per cent and the carbon dioxide line at the theoretical maximum percentage of carbon dioxide in the perfect flue gas. Thus, after making one analysis, the result may be plotted and a straight line drawn through this point and the horizontal axis at 20.9 per cent. If the analysis is correct, this line will cross the vertical axis at a point corresponding to the percentage of carbon dioxide in the perfect flue gas.

Once each week, a complete set of data is taken for each furnace, and the air leakage in the air preheater is calculated. Knowing the percentage of carbon dioxide in the flue gas and the stack temperature, the percentage of stack loss as well as the percentage of excess air can be read directly from Fig. 18. To use this chart, enter at the left at the point corresponding to the percentage of carbon dioxide in the flue gas; continue horizontally to the right until the carbon-dioxide curve is intersected; next, vertically up or down until the line representing the flue-gas temperature is crossed; then horizontally to the left where the per cent stack loss may be read.

For example, the following heater data show 8.7 per cent carbon dioxide in the flue gas leaving the air preheater and a stack temperature of 465 F. By the use of the chart, the stack loss is found to be 19.7 per cent.

Not only are the furnaces efficient, but approximately one third of the total process heat is furnished by exchangers. This, and the large yield obtained, result in a total heat consumption of approximately 550,000 Btu per bbl of raw, cracked distillate.

An example of the weekly furnace tests and calculations is given in Table 1. In this table, the weight of carbon dioxide leaving the preheater is exactly the same as the weight entering. The reason for the lower carbon dioxide percentage is that the

TABLE 1 WEEKLY FURNACE TESTS AND CALCULATIONS

CO_2 into air heater, per cent	10.0
O_2 into air heater, per cent	4.4
CO_2 out of air heater, per cent	8.7
O_2 out of air heater, per cent	6.6
Air pressure into air heater, in. water	4.4
Air pressure out of air heater, in. water	2.8
Temperature of flue gas into air heater, F	965
Temperature of flue gas from air heater, F	465
Temperature of air into air heater (atmosphere) F	70
Temperature of air from air heater, F	745
Draft into air heater, in. water	0.80
Draft out of air heater, in. water	2.9
Draft in top of furnace, in. water	0.15
Btu per hr	67,000,000
Stack loss, per cent	19.7
Efficiency (no radiation), per cent	80.3
Efficiency (3.5 radiation loss), per cent	76.8

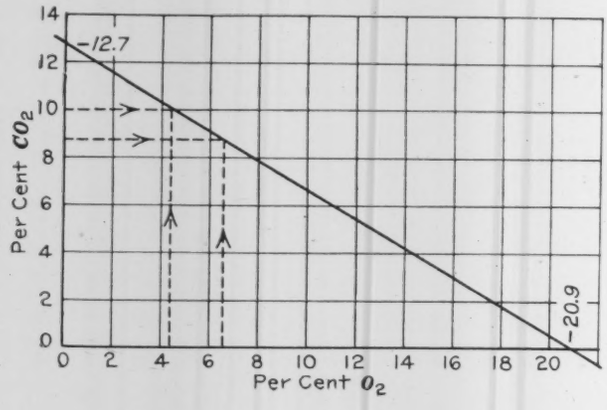

FIG. 17 CHECK CHART FOR FLUE-GAS ANALYSIS

(Analysis of fuel burned: C = 78.38 per cent; H_2 = 21.62 per cent; CO_2 in perfect flue gas = 12.7 per cent. All analyses of flue gases from a given fuel will lie in the same straight line, which if extended will intersect the oxygen line at 20.9 per cent and the carbon-dioxide line at the theoretical maximum percentage of CO_2 in the perfect flue gas.)

volume of flue gas leaving has been increased by air leakage.

Let L = per cent air leakage

Then per cent CO_2 in $\times$ 100 = per cent CO_2 out $\times$ (100 + L)

$$L = \frac{100\,(\text{per cent } CO_2 \text{ in} - \text{per cent } CO_2 \text{ out})}{\text{per cent } CO_2 \text{ out}}$$

$$= \frac{100\,(10 - 8.7)}{8.7} = 15 \text{ per cent}$$

When the preheater is in good condition, the air leakage is approximately twelve per cent. The leakage gradually increases, and sealing strips are changed when leakage approaches twenty per cent.

SAFETY CONSIDERATIONS

The six heaters are connected by walkways at three different levels. The walkways at the top of the heaters are protected by insulated walls on either side leading to protected stairways. Ladders are provided at strategic locations for quick escape in case of fire.

Should tube failure or other emergency occur the heaters can be emptied through the "fraid" lines, which are operated by remote control.

To prevent furnace explosions when lighting up the heaters, extreme caution is exercised. Air is circulated through the heater for 10 min before the burners are lighted. Draft and air pressure must be such that the torch will not be blown out when injected into the firing holes. Two men are stationed at the top of the heater; one takes charge of the lighting while

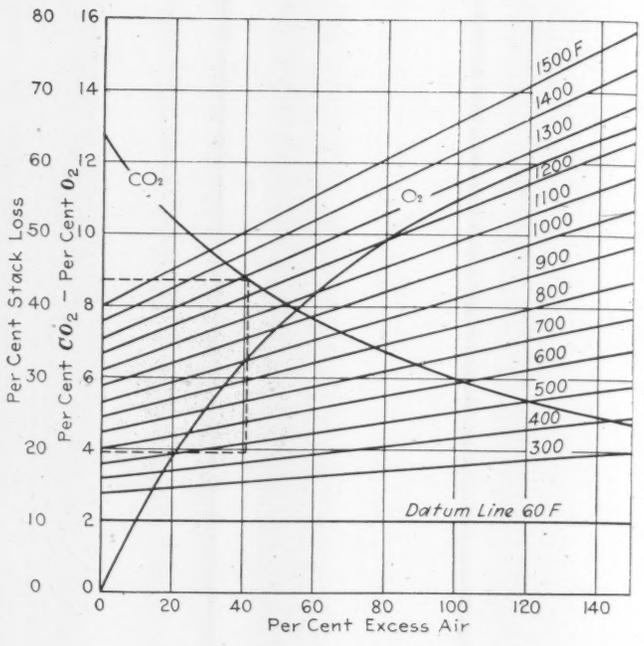

FIG. 18 STACK-LOSS CHART FOR REFINERY GAS

the other maintains direct communication through a speaking tube with a man, stationed on the bottom platform, who controls the draft and air pressure and observes the lighting process through a bottom inspection hole. The bottom man maintains Philco phone contact with the man at the control board, who regulates the flow of gas as directed. To light the burners the top man uses a gas torch. If the fire should go out for any reason, the gas is immediately shut off and the heater again purged for 10 min.

SUMMARY

The design of the furnace is unique in that it is the actual realization of what L. De Florez set out to accomplish. After years of experience and research, Sinclair engineers have developed the present design, which is believed to be the nearest approach to the ideal furnace that has yet been devised. It has high fuel efficiency and low furnace temperatures. Distribution of heat within the furnace is easily controlled, tubes are easily cleaned, and maintenance costs are low.

125-Octane Gasoline

ACCORDING to an article in *Business Week*, for June 3, 1939, a petroleum research laboratory has succeeded in producing for $50 a gallon a new fuel with a 125-octane rating that when first discovered cost $3600 to make. The best antiknock hydrocarbon fuel hitherto on the market is iso-octane with a rating of 100 which sells now in large lots for 50c a gallon. Three years ago it cost $25 a gallon. Used in the new high-compression aircraft engines, the 100-octane fuel increases climbing rate about 30 per cent and speed about 25 per cent as compared to the performance of 87-octane gasoline. It is expected that the new 125-octane fuel will attain commercial importance when it can be sold for $1 a gallon, since it shows 50 per cent greater power output than does iso-octane. As yet there is no engine which can operate commercially on 125-octane gasoline; but chemical engineers are doing their part to produce it cheaply and mechanical engineers are working on special metals and designs which will meet the problems of higher compression, higher engine temperatures, and cooling.

THE PELTON WATER WHEEL

II—Developments by Doble and Others, 1880 to Date

By W. F. DURAND

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(Continued from the June issue)

FOLLOWING Pelton's first patent in 1880, improvements and patents followed thick and fast. No attempt will be made to give any comprehensive list or discussion of the inventors or of the inventions which followed during the next quarter century. In many cases the same things were reinvented over and over, with only such modification of form or with some new combination with other features or elements of water-wheel operation as would serve for the basis of a fresh patent. It is desirable, however, to take note of the Dodd patent of April 16, 1889, which, together with the Colman patent, was, as we have seen, acquired by the Pelton Water Wheel Company. Note must also be taken of the second Pelton patent of August 27, 1889.

Dodd's patent claims read as follows:

1 A water-wheel consisting of the combination of a hub having a central encircling flange, annular separated disks secured to the flange of the hub, and buckets formed with two pockets side by side, having hemispherically-concaved faces separated by a central division-wall for receiving and splitting the stream, said buckets having flanges secured between the outer edges of the disks, substantially as described.

2 A water-wheel consisting of the combination of a hub having a central encircling flange, annular separated disks secured to the flange of the hub, and buckets having flanges secured between the outer edges of the disks, substantially as herein described.

3 A water-wheel consisting of the combination of a hub having a central encircling flange, annular separated disks secured to the flange of the hub, and buckets with flanges seated and secured between the outer edges of the disks, said flanges abutting against each other and forming a continuous ring, substantially as herein described.

In his specification, he recognizes the previous use of "scoop-shaped buckets," of "buckets having partially curved and partially flat faces," of "buckets curved in one direction," of "a bucket with a prow-shaped impact front" and of "the double bucket having a division wall on each side." He then states that he does not claim a double bucket with splitting wall, but does claim an improved shape in this subclass. The essential feature of the improvement claimed for the bucket was in giving it the form of a hemisphere which,

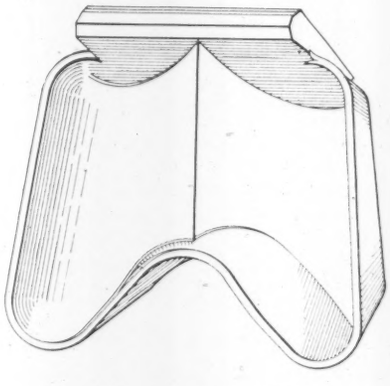

FIG. 14 THE DODD BUCKET

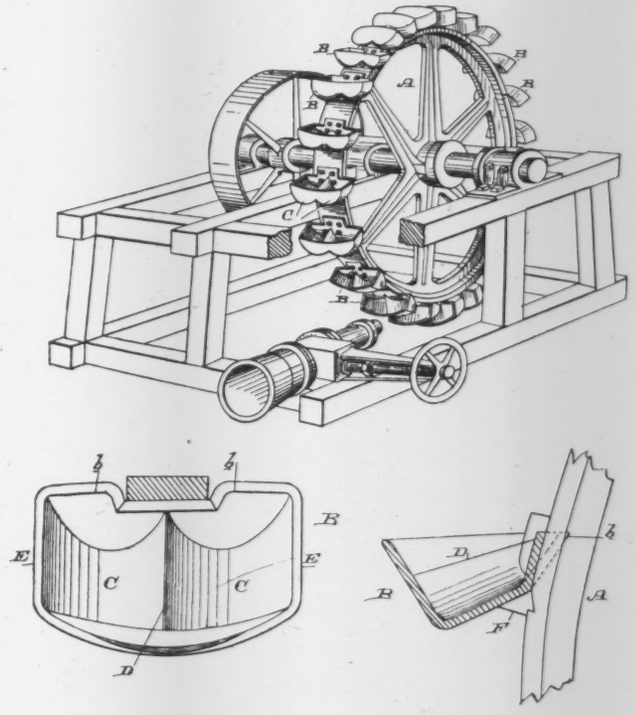

FIG. 15 SECOND PELTON PATENT

in the terms of his specification, "provides for a perfect discharge of the water in any and all directions, no matter in what position or at what inclination the bucket may be." The form of the Dodd bucket is shown in Fig. 14.

The essential feature of this patent, in so far as it represents any distinct modification over previous forms was, therefore, in the hemispherical form given to the buckets.

The second Pelton patent followed shortly after Dodd's, having the date August 27, 1889. The patent drawing for this bucket is shown in Fig. 15. The claims covered by this patent read as follows:

1 The buckets of a water-wheel, having the curved bottoms meeting at an apex or sharp ridge in the center and continuous with the inclined discharge sides, the bucket-fronts curved in the arc of a circle and inclined so as to narrow the buckets from the top toward the bottom, and the bottom and dividing ridge also declining from the rear toward the front, as shown and described.

2 The buckets of a water-wheel, having the curved bottoms meeting at a central apex or sharp ridge and continuous within the discharge sides, the convex front and the inclined bottoms, with the projecting angular lugs fitted to corresponding depressions or notches in the rim in which they are adjusted and retained, substantially as herein described.

3 The buckets of a water-wheel, with the curved bottoms meeting in a central apex or ridge and continuous with the discharge sides, the convex front, and the rear walls inclining backward upon each side of the wheel-rim, substantially as herein described.

Compared with the form of bucket covered by his first patent, it appears that the improvements are only in matters of detail in

To be presented at Pacific Coast meeting of the American Branch of the Newcomen Society of England, July 10, 1939, in connection with the Semi-Annual Meeting of The American Society of Mechanical Engineers, San Francisco, Calif., July 10–15, 1939. Part I on the development by Pelton and others prior to 1880 was published in the June issue of Mechanical Engineering, pp. 447–454.

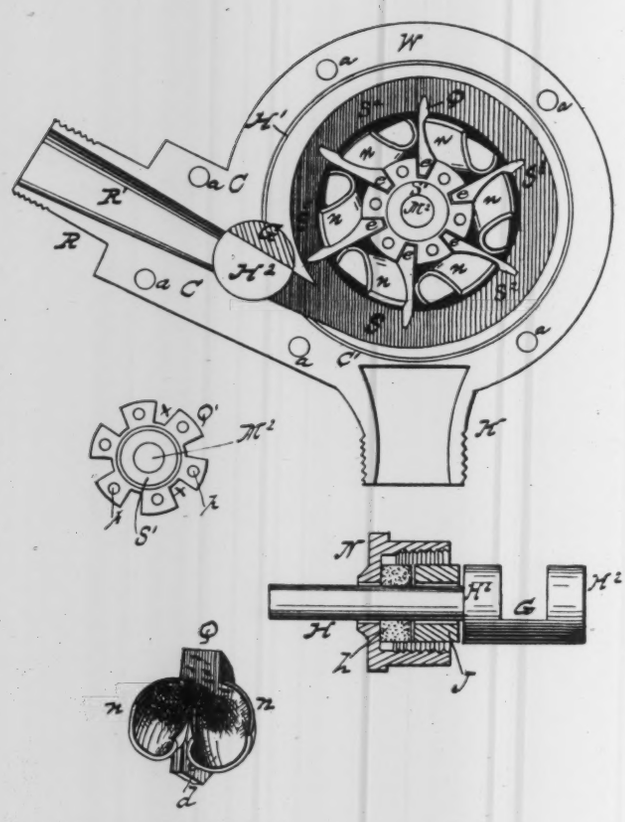

FIG. 16 DRAWBAUGH PATENT

the form and in the manner of attachment to the wheel. The specification, in referring to the bucket form, reads as follows:

> The front side of the bucket is inclined so that the bottom of the bucket is narrower than the top and is curved outwardly, as shown more distinctly at the lower right, so that the central portion of the front is at the greatest distance from the rear side. This central portion is also beveled off or made rounded and thinner than the remainder of the edge of the bucket, so that while the stream from the nozzle momentarily impinges upon it while the bucket is passing into position for the stream to strike its interior, this edge will not break the stream or scatter it.

The specification proceeds with a number of further statements regarding details of the form and of the action of the water thereon, all intended to give greater efficiency of operation and greater capacity to the wheel.

Taken as a whole, this form of bucket may be considered as a moderate step along the line of improvement which has led to the highly efficient forms of the present day.

As a matter of interest and of curiosity, note may also be made of a form of bucket patented by Daniel Drawbaugh under date of March 16, 1880 and thereby antedating Pelton's first patent by about seven months. The form of the bucket is shown in Fig. 16. The curious feature of this form of bucket was, however, that the jet was to be directed, in the words of the specification,

> . . . . . onto the periphery of the wheel which is provided with transverse paddles or blades, and at the base of each of said blades deflectors to catch the current by action and reaction, and yet allow it to move with rapidity and make its exit freely; a peculiar oval chambered casing in two main sections being employed to mount and inclose the wheel and direct the water thereon and lead it therefrom in a novel manner.

The interesting feature of this novel form of bucket is that if it were reversed in a radial direction so that the flat face *Q* might represent a lug for the attachment of the bucket between two wheel disks, then with the removal of the lug *d* and a little different development of the splitter partition between the two oval cups, it would represent an interesting approach to the general form of bucket as introduced some twenty years later by the Doble patents.

Following the second patent of 1889, the next decade furnished a great number of additional patents covering some modification of the basic elements of the Pelton bucket, in geometrical form, structural detail, or some combination thereof. With the exception of the Doble patents, to be referred to later, none of these variants of the Pelton form appear to have affected, in any significant degree or manner, the commercial practice with regard to this type of water wheel. However, for the convenience of those who might have an interest in following through this phase of the story in more detail, the following selection of the more important of such patents is given, with a brief word as to the leading features covered.

BIGGIO, Patent No. 356,977, Feb. 1, 1887. Bucket rectangular in plan form with sides and front forming the bucket inclosure and with the bottom shaped up in the form of a rounded ridge relatively wide and high at the front, and narrow and low at the back, something like a half cone with the base at the front, thus giving a form of blunt splitter or stream diverter. The front of the bucket is closed on either side of the rounded diverter and the back is open. This patent does not claim the rounded ridge in the bottom of the bucket as a splitter, but rather as an effective surface for receiving the impact of the jet and for guiding it to the reactive surfaces of the bucket.

GUNSOLUS, Patent No. 440,353, Nov. 11, 1890. Heart-shaped bucket with splitter extending from about the mid-point of the inside of one bucket backward and then circumferentially to join the next adjacent bucket near the center of its exterior—thus splitter lacking in front and wider part of bucket.

BOOKWALTER, Patent No. 445,845, Feb. 3, 1891. Splitter formed as sharp ridge extending circumferentially around the wheel rim, with special spoon-shaped buckets arranged in pairs, one on either side of the splitter.

RIDGWAY, Patent No. 453,449, June 2, 1891. Buckets in the form of cups attached in pairs on opposite sides of a disk, with double jet, one jet acting on each bucket of a pair.

DODD, Patent No. 454,638, June 23, 1891. Bucket with splitter and with the front boundary in the shape of a "sigmoid" forming the discharge for each of the curved bottom sections of the interior. Advantage claimed that the water is allowed to discharge in its "natural curves" but without specification of the character of a "natural curve."

PORTER, Patent No. 482,927, Sept. 20, 1892. Wheel disk formed with a nearly sharp edge cut into saw-teeth form, extending around the circumference and serving in some degree for impact but chiefly as splitter. Buckets take the form of so-called deflectors—practically cups of half-cylinder form.

PITCHFORD, Patent No. 485,477, Nov. 1, 1892. Bucket of typical Pelton form with splitter, but specially shaped in front to avoid contact of the front boundary with the jet at first contact, with consequent loss of power.

BERRY, Patent No. 493,239, Mar. 14, 1893. Bucket form shows practically two half cylinders joined edge to edge forming splitter and curved as a whole in the plane of the disk away from the nozzle in such way as to present, in the plane of rotation, convex instead of concave surfaces, thus giving in all positions of the jet relative to the bucket, nearly normal approach reckoned relative to sections through the bucket in the plane of the wheel disk.

BOOKWALTER, Patent No. 553,097, Jan. 14, 1896. Horizontal "hurdy-gurdy" with either single or double buckets, the latter showing substantially double half cylinders to form the splitter.

MOORE, Patent No. 559,740, May 5, 1896. Bucket rectangular in plan form with splitter formed as a blade standing normal to the flat bottom of bucket, with front edge at about center of bucket and thence extending to meet bottom of adjacent bucket at its front boundary.

HUG, Patent Nos. 576,728 and 576,849, Feb. 9, 1897. Both patents show much the same form of bucket, approximately of the Pelton form, roughly rectangular in plan view, with splitter, and with specially flared sides at the back to facilitate discharge of the water, combined with other structural features.

CAZIN, Patent No. 578,812, Mar. 16, 1897. Buckets of rectangular

plan form, nearly half-circular in cross section and with splitter carried high up above plane of bucket face. Makes no claim as to splitter. Chief improvement relates to special form of inner surfaces of buckets in order "to secure to the water jet . . . . a regular curved or segmental line of contact in whichever of the possible directions the jet may strike them . . . ." Also structural features. In this form of bucket the sharp front edge of the bucket cavity is continuous, at right angles to the line of the splitter, so that the result would be, on contact with the jet, a double division of the latter in two planes at right angles, interference and loss of useful effect.

JONES, Patent No. 599,845, Mar. 1, 1898. Bucket approximately rectangular in plan form and with splitter, all in general similar to the Pelton type, but with special form at the back to facilitate discharge of water at all points during its contact with the jet.

KENNEY, Patent No. 603,770, May 10, 1898. Bucket nearly circular in plan form with splitter through center and with special form permitting escape of water backward past wheel disk. Splitter edge also on lower part of outside of bucket. Also structural features.

BLUE, Patent No. 617,555, Jan. 10, 1899. Bucket substantially rectangular in plan form and with splitter, following Pelton general style. Front edge of bucket over middle portion cut down giving convex line for edge of splitter, seen in side elevation. This was intended to reduce resistance of bucket in entering jet and secure first contact of jet with splitter rather than with edge of bucket.

We come now to the period of the Doble patents which represent the second stage in the development of this type of hydraulic prime mover. The special significance of these patents lies first in their intrinsic value by way of advance on earlier forms, and second, due to the fact that in 1912 the Abner Doble Company and the Pelton Water Wheel Company became united under the style of the Pelton Water Wheel Company.

The entry of the Doble Company into the field of water-wheel design and manufacture forms an interesting story which may be related briefly as follows:

In 1850 in San Francisco, the partnership firm of Nelson and Baker was engaged in the manufacture of tools and equipment for mining and for general contracting work. At about this time, Abner Doble bought out the Baker interest, but the firm continued in the same general line of work under the style of Nelson and Doble. At a later time, Doble bought out Nelson

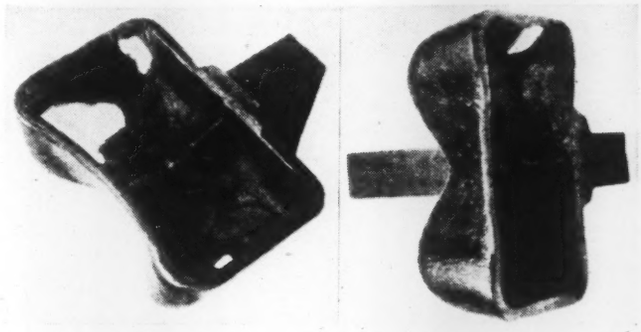

FIG. 17 SHOWING EFFECTS OF WEAR ON DODD BUCKETS

and, in 1889, with his sons, Robert McF. and Wm. A. Doble, the business was reorganized and incorporated under the firm name of the Abner Doble Company. Following this the business was expanded in the scope of its manufacture of mine equipment, including likewise agencies for pumps, air compressors, pneumatic drills, and the like. These lines of business naturally brought the Doble Company into close contact with the mines of California and with mining operations, and Abner Doble had already acquired important interests in the Amador Canal and Mining Company, which later became the Blue Lakes Water Company. Among other activities in Amador County, Doble acquired an interest in the Gover mine at Amador City. Here, in the late eighties, was a small power plant with water wheel fitted with Pelton buckets of the type prevailing at that time.

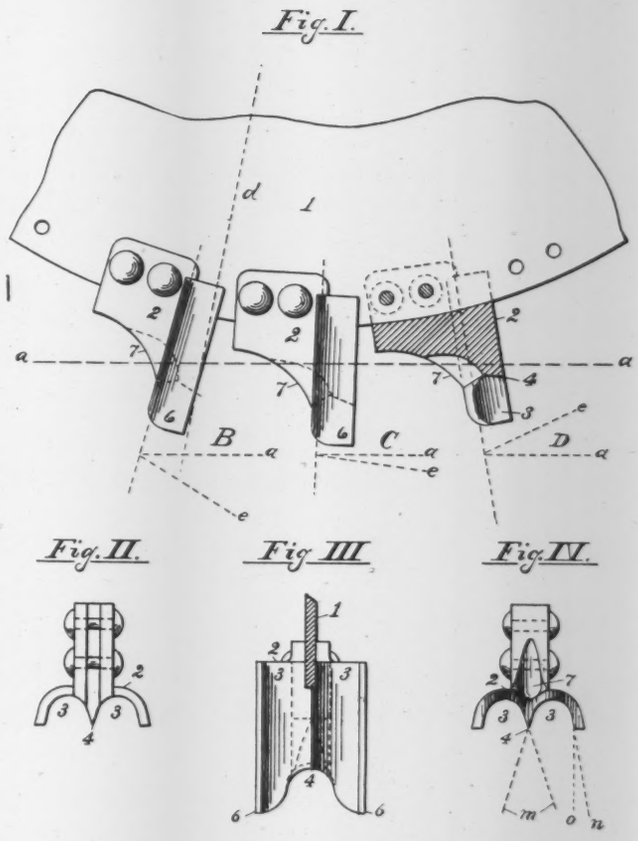

FIG. 18 DOBLE BUCKETS FOR SMALL JETS AT HIGH HEADS

On the occasion of a visit to this mine, the attention of Wm. A. Doble was called to the serious wear shown by the buckets of this wheel. The water was charged with sand and with the jet velocities employed, the wear had become so serious that frequent renewals of the buckets were necessary with resultant increase in cost of maintenance and in time lost in shutdown for repairs. The question arose as to whether this condition was peculiar to this plant or whether it was more or less general with water wheels of this type. A general inspection of the wheels in operation in these gold-mining districts of California showed that the trouble was widespread, constituting a serious drawback to the use of water wheels for power drive. See Fig. 17 for an illustration of this type of wear. This condition led Mr. Doble to a study of the causes of such abrasion and of the best means of minimizing its consequences. This study led to the broad conclusion that the cause was to be found in the irregular flow of the water over the inner surface of the buckets with the formation of local turbulence and eddies. This, with the presence of abrasive material in the water, would tend to localize abrasive action with the results as noted. The remedy seemed to lie in a form of bucket improved in such way as to secure an evenly distributed flow of water over the bucket surface, with freedom from eddies and the localized abrasive action resulting therefrom.

The culmination of these studies was expressed in three patents issued to Wm. A. Doble under dates of February 7 and September 19, 1899. The first of these patents was specifically intended for small jets under high heads. The form of the bucket is shown in Fig. 18, comprising two half-cylindrical bucket forms, open at front and back with splitter between, and

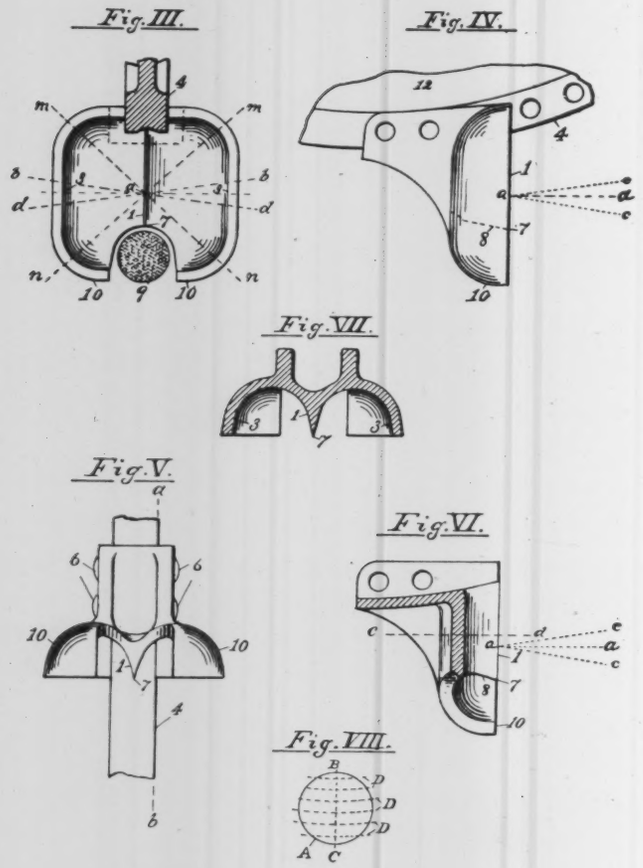

FIG. 19 SECOND DOBLE PATENT

with the front of the bucket cut away in such manner as to secure entrance of the bucket into the jet without disturbance and a "free discharge of the water in a course as nearly as possible reverse to the line of its impingement on the bucket." Emphasis is placed on the form of the front of the bucket, the part cut away being intended to avoid any tendency at first contact to split the jet first horizontally by the front edge and later vertically by the splitter. It will be noted that this is a distinct variant from the typical Pelton form.

Doble's second patent, shown in Fig. 19, bears the same date, February 7, 1899, and shows a bucket in plan form square with rounded corners and with central splitter following generally the earlier Pelton type, but with the front edge and part of the bottom cut out into a rounded notch somewhat larger than the size of the jet, and intended to secure for the jet the same type of contact with the wheel as in the form just described. Emphasis is again placed on the cutaway form at the front of the bucket, as intended to secure first contact of the jet with the central splitter only, thus avoiding any division or splitting of the jet by the front edge of the bucket, such division being in a plane at right angles to that for the division by the splitter.

Again about six months later, came the third Doble patent, under date of September 19, 1899. In this form of bucket we find a close approach to the latest and what appears to be substantially the final bucket form for a water wheel of the free-jet type. The patent drawing is shown in Fig. 20. The bucket is formed of two ellipsoidal cavities partly cut away and joined side by side to form the splitter. The section across the bucket line is shown in Fig. IV (patent drawing) and the general appearance of the wheel and jet in Fig. I. The front of the bucket is cut away in the same manner as in the preceding patent and for the same reason.

It results that for a bucket formed as shown in these patents of February 7 and September 19, 1899, when entering the jet, the first and only contact is with the splitter, as a result of which it is cleanly divided into two equal parts which are then diverted into the bucket cavities on either side.

In the specifications for this form of bucket, special emphasis is laid on the ellipsoidal shape as favoring a smooth flow of the water over the bucket surfaces, thus reducing the loss due to eddies and turbulence with corresponding gain in efficiency and freedom from localized abrasive wear.

At about the same time as the issuance of these patents, it appears that the Blue Lakes Water Company wished to install a power plant with water-wheel drive, and a contract for these wheels was made with the Pelton Company. A disagreement arose, however, between the Water Company and the Pelton Company as to the price and as to the manner in which the contract had been executed, resulting in delay in starting the construction, until finally the officials of the Water Company offered the contract to the Doble Company if they were willing to undertake the work. With these recent patents as a basis, the Doble Company immediately accepted the offer, constructed the wheels which were installed with results superior both in efficiency and in freedom from wear. This brought the Doble Company actively into the field of water-wheel manufacture as a rival of the Pelton Company, and they remained such, with a keen rivalry and a division of the field of manufacture between the two organizations, and likewise with continued litigation over patent rights. Finally in 1912, as previously noted, the two companies joined forces under the name of the Pelton Company with Wm. A. Doble as chief engineer. The union of the two organizations carried with it, of course, a pooling of all pat-

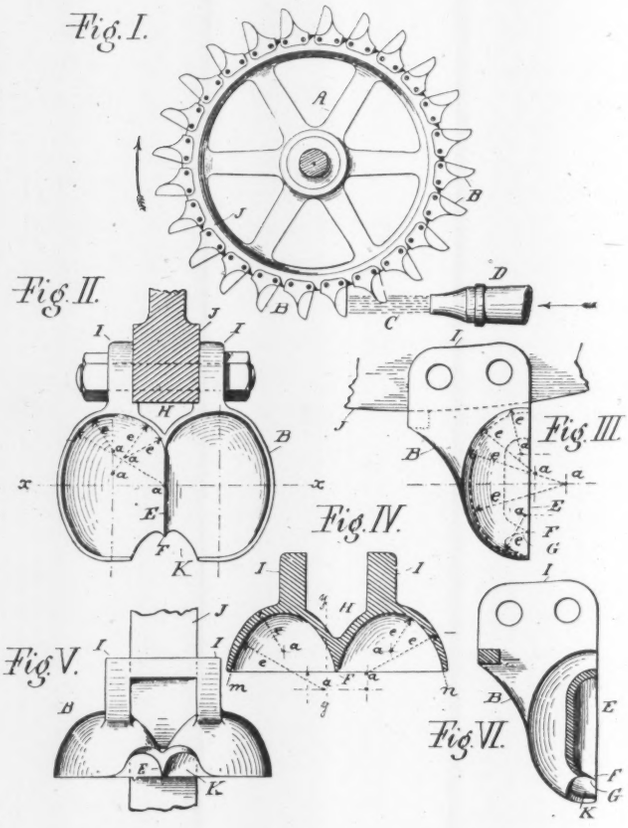

FIG. 20 THIRD DOBLE PATENT

ents, designs, and shop practices; so that subsequent to 1912 the Pelton Water Wheel in name includes the joint product of the previous Pelton and Doble patents and designs.

Pelton's patents dealt solely with the form of the bucket on which the water impinges. This was the essence of his invention. For this reason, the selection of other patents for the purpose of comparison and for showing the general state of activity in the field of invention relating to water wheels of this type during those early years, has been limited to those in the same general field. However, in order to meet the momentarily varying demands for power, the effective operation of a water wheel of this type requires at least one further essential element, and that is, suitable means for regulating the mass of water in the jet which impinges on the bucket.

This requirement has been met in two chief ways: (1) Diversion of part of the jet from actual contact with the bucket; and (2) regulation of the size of the jet by some form of nozzle with adjustable area of passage.

Apparently the first in point of time, brought in during the eighties of the last century, was a form of deflecting nozzle, hinged in such way as to admit of bringing the jet from full on the wheel to full off. This method of control was a natural, we may even say an inevitable, application of the method employed in moving and directing the stream of the "hydraulic giant," then in common use in the gold-mining districts of California. This giant was simply a nozzle connected to a suitable supply pipe carrying water under high pressure, from which it was discharged through the nozzle in the form of a high-velocity jet. In order to play this jet in different directions, thus bringing it to bear on different parts of the gravel formation under attack, the nozzle was attached to the supply pipe by a ball-and-socket form of joint, thus permitting motion in all directions. It was, then, a most natural transfer to apply the same type of motion for the movement of the jet of a Pelton wheel gradually or quickly off and on the bucket, as the demands for power might require; and if mechanical or hydraulic means could then be provided for effecting such movement, and if such means could itself be placed under the control of a speed-sensitive mechanism, all the elements would be available for control of the wheel at constant speed under fluctuating power demand. As is well known, means for effecting such movements under control have been found, and the modern water wheel, no matter what the conditions of fluctuating load, is subject to close and accurate speed regulation.

It does not appear that this particular form of regulation for free-jet water wheels was ever patented as such. Mechanical details of the method have been subject to patent, but the basic idea is apparently too simple and too obvious to admit of recognition as an invention. The next device in the order of time seems to have been the so-called jet deflector. The earlier forms comprised simply a flat plate hinged on the nozzle near its tip in such manner that it could be brought around, cutting obliquely into the jet, thus diverting it in whole or in part from the wheel. In still another form of jet deflector, a cylindrical ring, a little larger than the jet, was located just beyond the tip of the nozzle, and hinged so that it could be swung from a position axial with the nozzle, with the jet running full and free, to a position angled downward, thus diverting the jet, in whole or in part, from the wheel. In later types of this device, the flat plate or ring took the form of a curved hood, more effectively cutting into and diverting the stream, but embodying after all the same basic idea. See Fig. 21. These devices again, so far as the present writer is aware, were not made the subject of patents. The use of a hinged deflector of some kind was, in fact, well known in connection with the use of the hydraulic giant previously mentioned. The movement of the nozzle, permitted by the ball-and-socket joint, was, of course, strongly resisted by the hydraulic forces brought into play, and as an aid in effecting the movement, a deflecting plate was often fitted to the end of the nozzle, hinged in such way that it could be brought partially into the stream, thus deflecting a portion in such direction as to give a reacting force in the direction of the desired nozzle movement. The use of a deflecting plate or hood in connection with a nozzle and issuing jet was, therefore, a familiar feature in the mining practice of the day and its transfer to the water-wheel jet for the purpose of regulating the amount of the jet impinging on the wheel was almost a foregone conclusion.

These methods for regulating the speed of the wheel, especially in their earlier forms, were somewhat clumsy and involved rather unsatisfactory mechanical detail. Furthermore, they only in part met the requirements for speed control with the full economic use of the water. It is clear that if the wheel is allowed to run for any considerable period of time with the nozzle full open and the jet partly or wholly diverted from the bucket, a needless waste of water will occur. What is then required is a second major movement of some form of control valve in the main supply line which will reduce the amount of

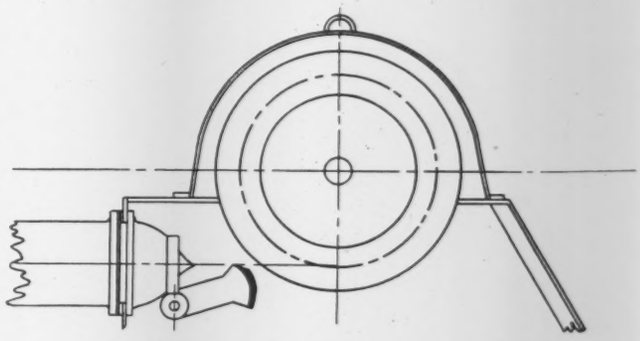

FIG. 21 ONE FORM OF JET DEFLECTOR

water flowing in the line, to just that required to maintain the speed of the wheel with the reduced jet full on the bucket. However, any relatively rapid closure of the flow in the main supply line will give rise to a serious and perhaps dangerous pressure rise in the line—the well-known phenomenon of water hammer. The complete solution required, therefore, a prompt diversion of the flow impinging on the buckets, a slow reduction of the total flow in the main supply line coupled with a gradual return of the reduced jet to full play on the buckets. This focuses attention on the requirement for some form of regulating or control valve in the main supply line, so linked with the other control features that these various conditions may be effectively brought about.

Previous, however, to the full realization of any such ideal, various forms of nozzle-regulating devices gained limited recognition and use. Thus in some cases a form similar to the old-fashioned molasses spigot was employed, comprising little more than a curved plate sliding across the nozzle opening and thus regulating the size of the stream reaching the buckets. Again use was made of a heavy plate or bar sliding in guides across the front of the nozzle and provided with a series of orifices arranged step-wise as to size, thus giving a corresponding step-wise variation in the size of the jet. In a third form, known as the "pin nozzle," a long cylindrical axial bar, turned in steps as to diameter, was fitted with means for moving it along axially, so that one size after another could be brought to the mouth of the nozzle and thus made effective in regulating the size of the jet.

These various forms of device for jet regulation were obviously crude, inadequate, and unsatisfactory, especially from the viewpoint of the requirements for prompt speed regulation with

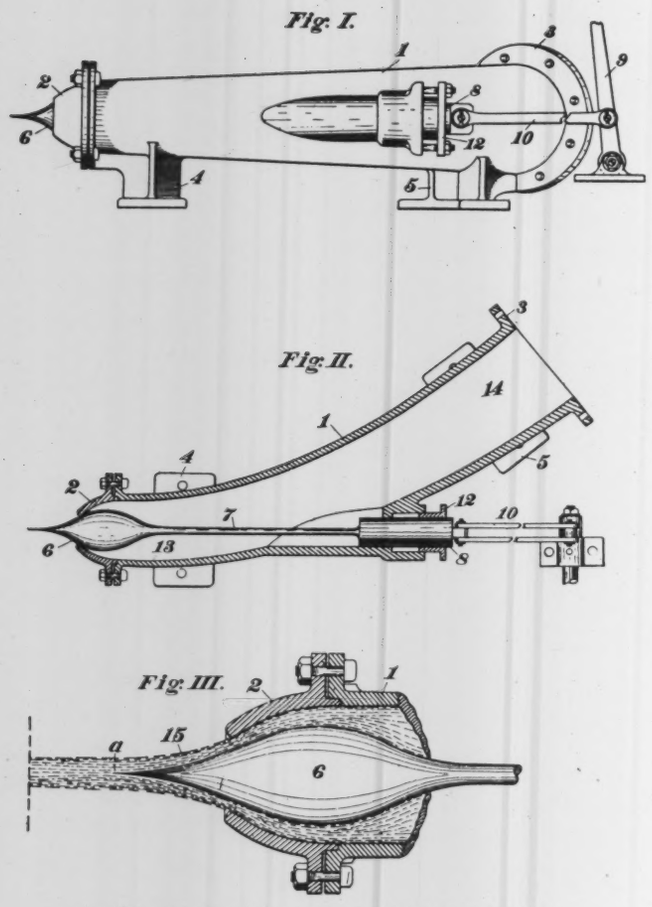

FIG. 22 DOBLE PATENT FOR REGULATING NOZZLE

efficient use of water, in response to fluctuating power demand.

During the closing years of the last century, Wm. A. Doble, together with his study of bucket forms for free-jet water wheels, had included this general problem of jet control and, under date of October 30, 1900, was granted the first of a long series of patents issued during the following fifteen or sixteen years and dealing with various phases of the control of jets for water wheels of this type. The first of these patents covered the Doble needle nozzle as a means for the more efficient formation of the issuing jet with varying and controlled volume of flow.

This type of control valve for regulating the flow of water in a pipe line has since become so well known that no description in detail is necessary. It gave direct means for securing a regulated flow of water to the wheel, always in the form of a smooth properly formed efficient jet, and without the head losses involved in passing through other forms of valve under partial opening. The patent drawing for the 1900 patent for this device is shown in Fig. 22. One feature of this device, specially noted in the first patent claims, was a proportion of the needle stem diameter to length (Fig. II), permitting a certain degree of flexibility of the stem relative to the forces in play, as a result of which the bulb of the needle would be free to center itself more accurately relative to the issuing jet. In later designs, with accurate machining and heavy construction, this feature has been found of lesser importance.

However, prompt action of this valve in regulating the flow of water to the wheel would still be liable to produce dangerous water-hammer pressures. To meet the situation fully, then, some combination was required which, with prompt reduction of jet action on the bucket, would insure a slow reduction or closure of the flow in the line. For the former, the deflecting nozzle was, at this time, the most available, and for the latter, the Doble nozzle with movable needle provided an effective and satisfactory means. The Doble patent under date of February 9, 1904, with reissue February 27, 1906, shows a combina-

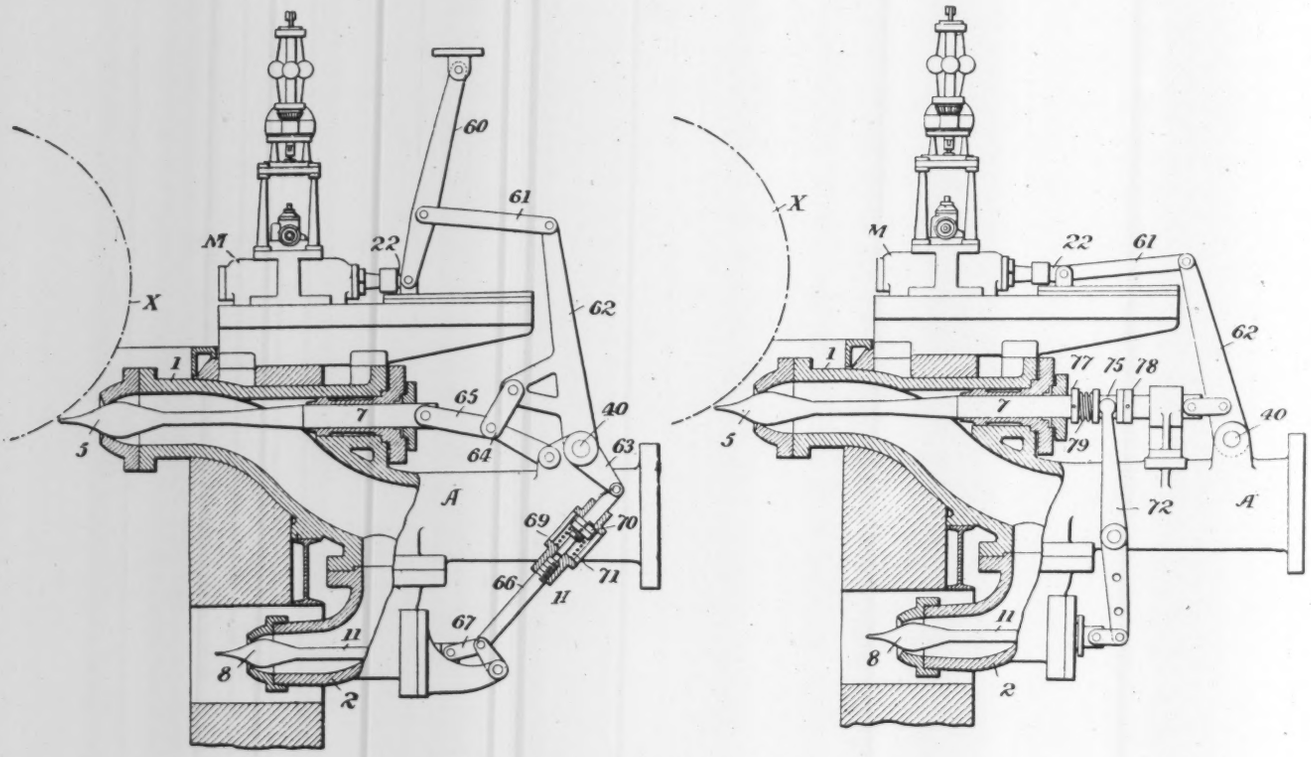

FIG. 23 DOBLE DOUBLE-NOZZLE SPEED REGULATOR

tion of this character. The deflecting nozzle removes quickly the jet from the wheel (in whole or in part) following which the needle is closed down more slowly and the nozzle, with reduced jet, brought back to act on the wheel.

It is obvious that in place of the deflecting nozzle, the use of some form of by-pass or waste valve back of the nozzle, opening either by direct connection with the jet control mechanism or under a moderate and admissible rise of pressure, furnishes also a solution of the problem; and such valves have, in later years, become a commonplace of hydraulic installations. As a special form of such by-pass relief valve, the Doble patent under date of August 18, 1908, shows a double needle nozzle which, in principle, still remains a standard form of equipment of water wheels of the free-jet type. The patent drawing of this form of nozzle is shown in Fig. 23. In this device, there are fitted two nozzles, one below the other, with the discharge line of the lower running clear of the bucket. In the later and more definite forms of this device, the two needles are simply connected at the opposite ends of a lever pivoted near or at the middle. The connection to the upper or bucket needle is positive; that to the lower or discharge needle is through a so-called hydraulic cataract—that is, a device in which a quick movement of the control mechanism will carry through to a correspondingly prompt movement of the needle, while slow movement of the control, as a result of fluid leakage or by-pass, will produce only a partial or perhaps no movement of the needle. Again, this waste needle opens against a spring which, as soon as the control movement ceases, tends to return the needle to the closed position, which movement is permitted by slow fluid by-pass. In the case of partial or complete closure of the upper needle with a quick and positive movement, the waste needle follows in the opposite sense and promptly opens, thus diverting the water, in whole or in part, from the wheel. The control movement then ceases with the wheel under normal speed with reduced jet and with the remainder of the flow wasting through the lower nozzle. Immediately, however, under the force exerted by the spring and permitted by the by-pass, the waste needle begins a slow movement toward closure, and finally reaches complete closure with the waste shut off and the wheel at normal speed under the new conditions of load. Since the timing of the by-pass in the cataract device is under control between any limits desired, the time of waste closure can be brought to any period required, having in view the water-hammer characteristics of the line. With sudden increased demand, the device, as is seen, limits the speed at which the upper nozzle can be opened up and this again will protect the line against undue pressure changes. The general arrangement of such an installation is shown in Fig. 24.

The first patent form of 1908 was followed by some six or seven other patents covering various improvements in detail or changes in form and construction, but all intended to furnish varying and improving solutions of this general problem, and leading progressively to the general type of arrangement, in Fig. 24.

Since the period of these patents, the advance has been by way of refinements and improvements in detail of form, finish, and mechanical design. Furthermore, with the lapse of all of the earlier patents, the basic ideas have long since become free to the industry at large; and water wheels of this general type, properly called Pelton wheels, form a part of the accepted hydraulic practice of the day throughout the industrial world.

It is no part of the purpose of this paper to discuss or describe this modern practice. It is well known to those interested in hydraulic power engineering. Brief note may, however, be made of one or two features of the modern trend of practice.

Thus small modifications of bucket form with greater smoothness of internal finish have improved, by a few points, the efficiency of the wheel. Fig. 25 shows historically a succession of bucket forms. Two wheels on one shaft, overhung, with bearings between, known as the "double overhung unit" has become a favorite form for the increase of power in a single unit. Fig. 26 shows one such wheel of a 25,000-hp double overhung unit.

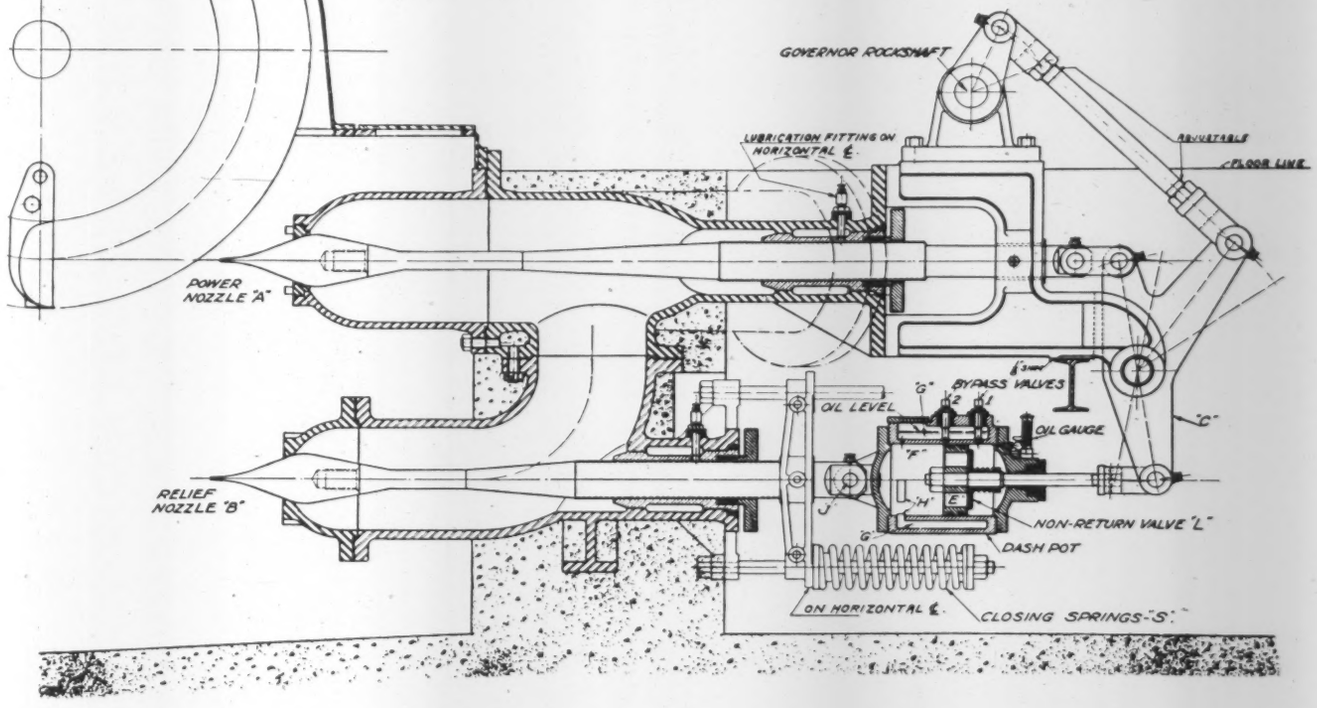

FIG. 24 PELTON REGULATING NEEDLE NOZZLE WITH AUXILIARY RELIEF-NOZZLE MECHANISM

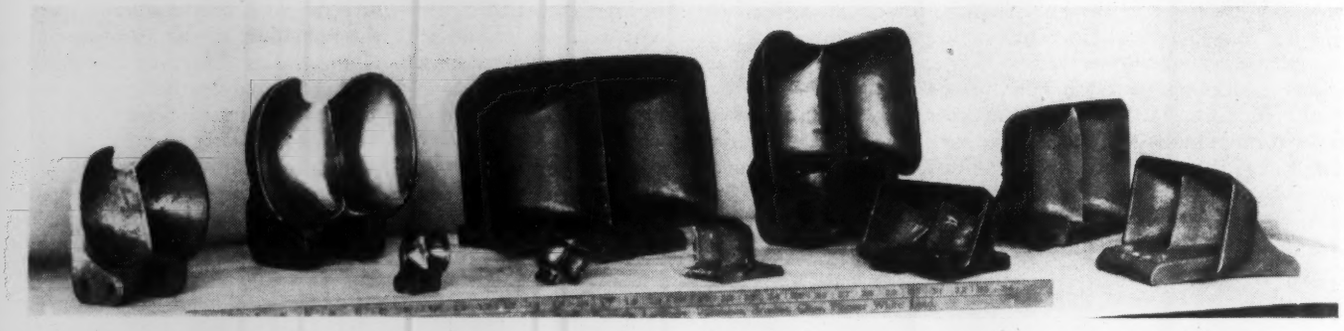

FIG. 25 HISTORICAL SUCCESSION OF BUCKET FORMS

In the matter of jet control certain modern installations show an interesting reversal to earlier practice in the use of a jet deflector in combination with a needle nozzle, instead of the double needle nozzle shown in Fig. 24. In this form of arrangement, the immediate deflection of the water from the wheel without change of the velocity of flow in the pipe line is effected through the governor and some form of servomotor which swings the deflector into the jet with partial or complete diversion from the wheel. Following this the needle in the main nozzle starts a slow closure accompanied by a gradual retreat of the deflector, until, when steady conditions are again reached, the deflector is clear and the flow in the main line has been reduced gradually to that required for the new power demand. It is seen that this is simply a variant in the manner in which prompt diversion of the water from the wheel is effected, followed by a slower adjustment of the flow in the main line to the momentary power requirement, and ending with the reduced jet acting normally on the wheel.

The modern Pelton water wheel with installation complete will then comprise the following major features:

1 A set of buckets of modern refined form but holding still the essential features of the early Pelton design.

2 The shaft, spider, and mounting with which we are not here concerned.

3 A needle nozzle under governor control, coupled with some form of by-pass waste—double needle nozzle, jet deflector, or pressure-operated relief valve.

4 A speed-sensitive device (governor) linked to one or more servomotor devices, these in turn linked to the parts, the movement of which is required for the regulation of the water to the wheel.

Our survey of the development of the Pelton form of water wheel has thus far included reference to only one jet per wheel. In practical applications, however, two and sometimes more jets have been employed, contacting the buckets at an angular spacing sufficient to avoid interference on the same bucket between water from successive jets. No difference in form of bucket or principle of action otherwise is involved in the use of multiple jets, and this brief reference will furnish sufficient recognition of this variant form of wheel.

Nearly sixty years of refinement of bucket form with added features of jet control to meet the existing modern requirements for speed regulation, have made of Pelton's mining water wheel of 1880, a prime mover highly efficient, reliable, and durable. The early efficiencies of about 50 per cent have been replaced by values of 88 per cent or even better. The early capacities of from 50 to 100 hp have been replaced by values of from 10,000 to 40,000 for a single wheel or twice these figures for a double overhung unit.

The heads commonly met with in the early days in California were from 50 to 300 ft. With peculiar adaptation to high heads, a degree of adaptation found in no other type of water wheel, modern installations have reached heads of 3000 ft and upward.

This represents a far cry from the Pelton wheel of 1880 as shown by the model which Pelton brought to the Rankine and Brayton shop for judgment as to its merits. If Pelton had not taken this step at that time, presumably someone else would have taken a somewhat similar step at some time not far distant. Who can tell? In any event Pelton did take the step; he succeeded in interesting Brayton, the matter was put on a commercial basis, was followed up with improvement and refinement as we have seen, and to Pelton must go, after all, the credit of having initiated this unfolding sequence of refinement and growth which has led to the splendid results shown by the modern installations, representing, after all, only improved forms of the California mining hurdy-gurdy.

ACKNOWLEDGMENT

In the preparation of this historical sketch, the author is indebted to the following principal sources:

"The Tangential Water Wheel," by Wm. A. Doble, Transactions of the American Institute of Mining Engineers, vol. 29, 1899, p. 852.

Mémoires de l'Académie des Sciences, 1767.

Hydraulics, D'Aubuisson de Voisins.

Conversations with Wm. A. Doble.

Old trade catalogs, drawings, and photographs furnished by the Pelton Water Wheel Company.

Records of the U. S. Patent Office.

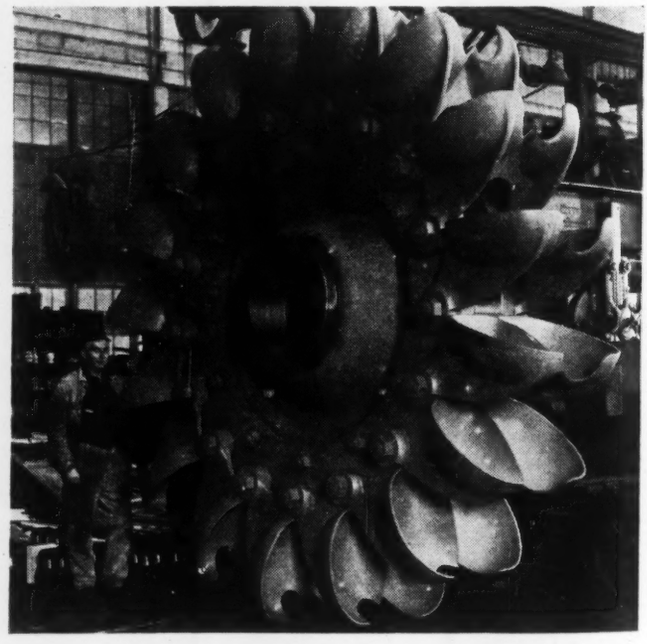

FIG. 26 ONE WHEEL OF A DOUBLE OVERHUNG UNIT OF 25,000 HP

FUEL SAVINGS DETERMINE DESIGN OF SUPERPOSED UNIT

For Addition to L Street Station of Boston Edison Company

By GEORGE A. ORROK, JR.

EDISON ELECTRIC ILLUMINATING COMPANY OF BOSTON, BOSTON, MASS.

THE EXISTING equipment in the L Street Station has a capacity of 198,000 kw which is augmented by tie lines from the Edgar Station ample to carry peak loads which are anticipated in the near future. Of this capacity, 96,000 kw are supplied by eight vertical turbines served by forty-eight 200-psi boilers, which naturally are quite uneconomical to operate. The remaining 102,000 kw are furnished by three horizontal turbines served by twelve 300-psi boilers. These turbines are in good condition and can give many more years of useful service. The boilers, however, are not comparable to modern units in economy.

With these conditions, it was apparent that a superposed high-pressure unit at this station would make desirable fuel savings: First, it would provide economical boiler capacity for the horizontal turbines; second, the addition of the high-pressure turbine would form a generating unit with economy comparable to the best; third, the 300-lb boilers released would give a reliable source of steam to operate the vertical turbines for peak-load service.

Preliminary economic studies are summarized in Fig. 2 and confirm the general conclusions just stated. Various schemes were estimated as shown. Load-duration curves were prepared from which the power generated by the new units and the operating savings were determined. The savings were capitalized and plotted with the costs. This analysis indicated that a topping unit of rather small size, over the 300-lb turbines, would earn the best return on the investment. Other types and sizes of units could not be justified by savings and, even if capacity were needed, the study indicated the topping unit should be first installed. The decision was made to purchase a 20,000-kw high-pressure turbine, which was the standard size nearest in capacity to the economic size.

The next question was to select the heat balance. At present, condensate at 185 F is discharged from the 300-lb turbines after passing through oil and air coolers and barometric heaters. Since the top will deliver less steam than is required by the 300-lb machines, there will be a surplus of condensate at normal station loads available for the high-pressure boilers. For periods of light loads, adequate condensate storage will be installed. This means that the 300-lb boilers will serve as evaporators for make-up to the high-pressure boilers.

The decision to use 185-F condensate at once made the decisions as to the proper heat balance definite. It was apparent that the new oil and air coolers must be cooled from some other source of water. Fortunately a convenient supply was found in the salt water pumped to the gas scrubbers installed in the two chimneys serving the 300-lb boilers. The salt water will pass through a heat exchanger and cool circulating fresh water supplying the air and oil coolers for the generator and the bearings of the station auxiliaries.

Early studies had considered a deaerating and a crossover heater. More complete analysis showed that a crossover heater could not be justified for the following reasons: Considerable difference exists between the efficiency of the proposed 1200-lb and the existing 300-lb boilers. The top supplies steam for only a part of the 300-lb turbines; hence the 300-lb boilers must be run the greater part of the time to operate the remaining turbines. Any steam taken at 300 psi for heating the feedwater of the 1200-lb boilers would mean increased operation of the low-efficiency 300-lb boilers. This would cause a thermal loss greater than any possible gain in cycle efficiency. It is believed that this will be found generally true where topping units are installed which do not cover the entire low-pressure plant.

This same argument might have been extended somewhat to bleed heating at lower pressures; however, since heating to deaerating temperatures was necessary, and as the reliability of turbine-driven boiler feed pumps seemed desirable, a balance was found between the power requirements of the boiler feed pump and steam for deaeration, at a pressure of 55 psi gage, corresponding to a feedwater temperature of 300 F.

With these decisions made, the addition of a gland-steam condenser in the line to the deaerator completed the flow diagram and the heat balance, as shown in Figs. 1 and 3.

TABLE 1 LIST OF PRINCIPAL EQUIPMENT

Turbogenerator	Westinghouse Electric
Rating, 20,000 kw, 37,500 kva, 3600 rpm	
Steam conditions, 1200 psi at 910 F to 300 or 200 psi	
Boilers	Combustion Engineering
Two at 375,000 lb of steam per hr at 1200 psi and 910 F	
Induced-draft fans	B. F. Sturtevant
Two 1000-hp variable-speed	
Hydraulic couplings, two	American Blower
Forced-draft fans	B. F. Sturtevant
Two 300-hp with vane control	
Pulverizers	Combustion Engineering
Four 200-hp	
Boiler feed pumps	Ingersoll-Rand
Four 1250-hp capacity, 400,000 lb per hr each	
Dust catchers	Research Corporation
Two Cottrell precipitators	
Deaerators	Worthington
Two, capacity, 400,000 lb per hr with steam at 55 psi and 300 F	
Ash-handling system	United Conveyor
Completely pneumatic	
Boiler control, pneumatic	Bailey Meter
Superheat control, electric	Leeds & Northrup
Boiler-feed-pump control, pneumatic	Republic Meter
Desuperheating and pressure-reducing equipment	Republic Meter
Large motors	General Electric
For boiler feed pumps, fans, pulverizers	
Boiler-feed-pump turbines	Moore Steam Turbine
Two 1350-hp, steam, 300 to 55 psi	

Contributed by the Fuels Division and presented at the Fall Meeting, Providence, R. I., Oct. 5–7, 1938, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

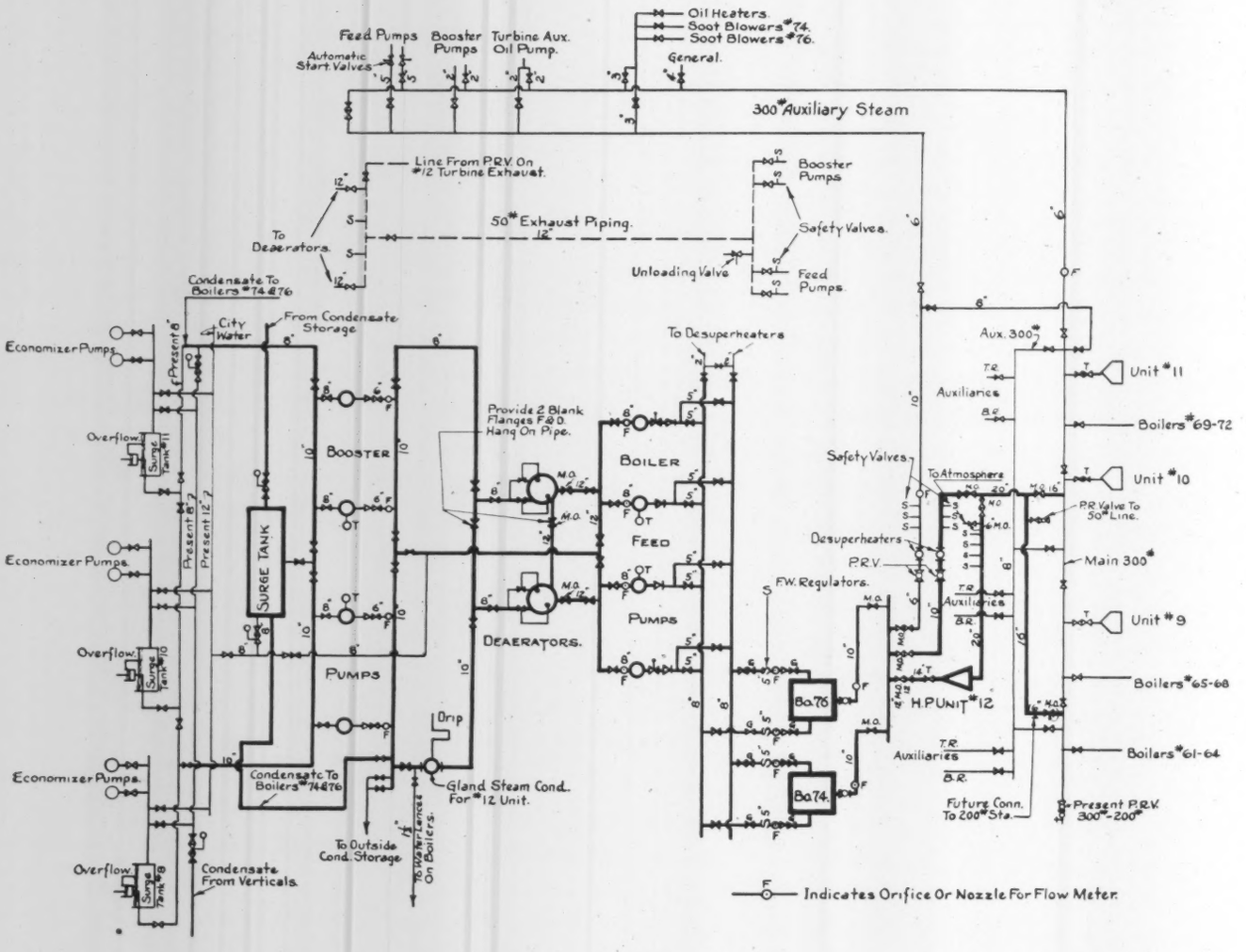

FIG. 1 FLOW DIAGRAM

As the study of the heat balance had considered only the normal source of power for driving the boiler feed pumps, the general question of auxiliary power next required attention. Alternating-current motors operating at 2300 v were finally chosen, based on the present practice in the more modern stations and the difficulty and expense of procuring direct-current motors of adequate size and speed (1250 hp for the boiler feed pumps and 1000 hp for the induced-draft fans).

Metal-enclosed switching equipment has been provided for controlling the 2300-v auxiliaries of the new unit and feeding the transformers for the lower-voltage power and lighting services. The circuit breakers are of the Deion air-break type. This equipment is mounted in a separate room from the main switchboard and will function as a substation by itself.

After the basic design had been roughed out, the next step was the selection of proper equipment. The turbine specification offered little of particular interest, with the exception of the large-sized generator and the possibility of future operation at 200-psi back pressure. The steam condition of 1200 psi at 900 F was determined since expansion from this condition gave exhaust steam of proper temperature for the existing 300-psi 625-F turbines and also, by coincidence, for the 200-psi 525-F turbines. As finally purchased, the turbine has a nominal rating of 20,000 kw; the generator, 37,500 kva, to correct a deficiency in kva capacity in existing units, caused in part by rating up existing turbines. Actually the turbine is expected to have a capacity of 25,000 kw at 300 psi and 31,250 kw at 200 psi back pressure. The speed is 3600 rpm which with the throttle conditions of 1200 psi and 900 F gives the lowest-cost machine. In the comparison of bids, no very good case could be made for hydrogen cooling of the generator for this size of machine. The cost was higher and operating difficulties were feared.

Normal excitation is supplied by direct-driven exciter and pilot exciter, since the manufacturer convinced the company that commutation at 3600 rpm would be satisfactory.

The generator is equipped with a CO_2 system of fire protection.

The boiler specification offered a few more problems. The decision in favor of pulverized-coal rather than stoker firing was made with little discussion despite the fact that all the previous electrical-generating experience had been with stokers. However at the Kneeland Street steam-heating plant there is a modern pulverized-coal installation of comparable capacity, and a comparison showed that first cost, reliability, maintenance, and operating cost all favored pulverized-coal firing for L Street conditions.

With pulverized coal it was possible to design the ignition oil-torch system to use heavy oil and at little expense to provide relay capacity for the loss of a pulverizer. The system can be extended for full-capacity oil burning if desired in the future.

At Kneeland Street slagging has never been a problem perhaps because of steam-heating load factors. However, boiler cleanliness has always been a serious problem in the stoker-

fired plants, hence an important part of the specification was that devoted to securing a boiler which could be maintained clean. To this end, furnace heat release was specified at 25,000 Btu per cu ft per hr maximum, and various clauses were added to give as low a gas temperature entering the boiler tubes as was consistent with the desired superheat. The boiler purchased has these features and gas will enter the first tube row at 2100 F which is below the softening temperature expected in the ash.

Another problem occurred in controlling superheat to the close limits necessary with 910 F steam. Despite the excellent performance of radiant superheaters elsewhere, it did not seem wise to become involved in their design problems, and this left damper control as the desirable alternate. A mistrust of dampers in general and hot dampers in particular led to the specification that maximum gas temperature at the damper be less than 1000 F. The final design is a multiple-hinged-leaf damper with individual rod operators for each leaf.

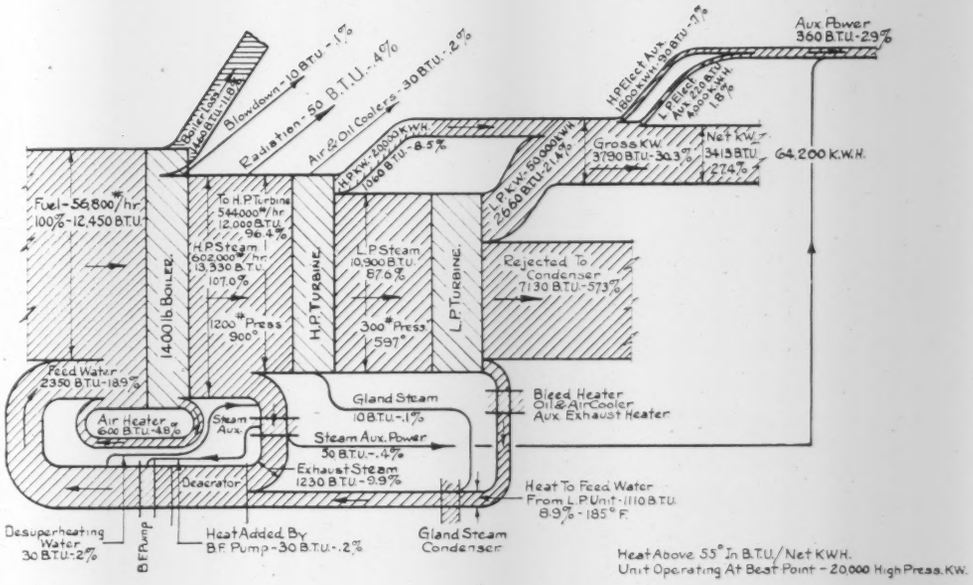
Aux Power 360 B.T.U.-2.9%
Boiler Losses 1160 B.T.U.-11.8%
Blowdown-10 B.T.U.-.1%
Radiation-50 B.T.U.-.4%
Air & Oil Coolers-30 B.T.U.-.2%
H.P. Elect. Aux. 300 K.W.H.-3900 B.T.U.-.3%
L.P. Elect. Aux. 220 K.W.H. 4000 B.T.U.-.18%
H.P. K.W.-20000 K.W.H. 1060 B.T.U.-8.5%
Gross K.W. 3790 B.T.U.-30.3%
Net K.W. 3413 B.T.U. 27.4%
64,200 K.W.H.
L.P. K.W.-50000 K.W.H. 2660 B.T.U.-21.4%
Fuel-56,800 #/hr 100%-12,450 B.T.U.
To H.P. Turbine 544000 #/hr 12,000 B.T.U. 96.4%
H.P. Steam 602,000 #/hr 13,330 B.T.U. 107.0%
1200 # Press 900°
1400 lb Boiler
H.P. Turbine
L.P. Steam 10,900 B.T.U. 87.0%
300 # Press 597°
L.P. Turbine
Rejected To Condenser 7130 B.T.U.-57.3%
Feed Water 2350 B.T.U.-18.9%
Air Heater 600 B.T.U.-4.8%
Steam Aux.
Gland Steam 108 B.T.U.-.1%
Steam Aux. Power 50 B.T.U.-.4%
Exhaust Steam 1230 B.T.U.-9.9%
Deaerator
Bleed Heater Oil & Air Cooler Aux. Exhaust Heater
Heat To Feed Water From L.P. Unit-1110 B.T.U. 8.9%-185° F.
Desuperheating Water 30 B.T.U.-.2%
B.F. Pump
Heat Added By B.F. Pump-30 B.T.U.-.2%
Gland Steam Condenser
Heat Above 55° In B.T.U./Net K.W.H.
Unit Operating At Best Point - 20,000 High Press. K.W.

FIG. 3 HEAT-STREAM DIAGRAM

The boiler manufacturer did not offer his special tangentially fired furnace because it is not advantageous for a small-sized unit. However by firing horizontally under the mud drum there will be not only an effective use of the furnace volume but also little tendency to plaster slag on the lower part of the boiler tubes.

The next item studied was dust catchers. Here the only important specification was high efficiency, and bids were received on electrostatic, wet-scrubber, and mechanical types. In the comparison, there were figures on the maintenance cost of wet scrubbers at the Kneeland Street heating plant and on various mechanical types at the generating stations. Data were collected from other companies on the performance and operating cost of the Cottrell type. A careful comparison of the cost of owning and operating equipment of adequate efficiency (better than 90 per cent) was made, and precipitators were purchased.

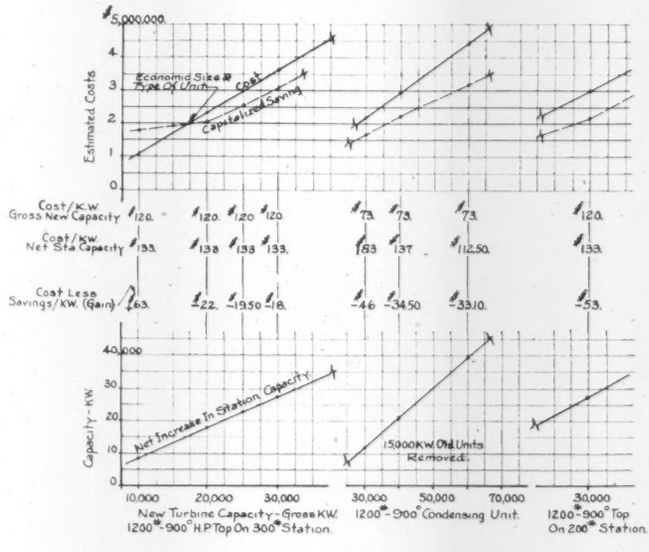

FIG. 2 PRELIMINARY ECONOMIC STUDIES

This decision determined the final draft conditions which showed that the fans for L Street would require 1000-hp motors. The most reliable type available was the constant-speed induction motor. Fan bids were received on vane control, hydraulic-coupling control, and on dual-vane control, with forced- and induced-draft fans on one shaft. Again maintenance and operating costs received careful attention. The efficiency of variable-capacity devices at partial loads was considered and the results were applied to a load-duration curve. Although the dual fan showed somewhat the better on cost comparison, the decision was finally made to purchase vane-controlled forced-draft fans and hydraulic-coupling-controlled induced-draft fans. The advantage of separate units, standard design, and the reduced wear of the variable-speed induced-draft fan overbalanced any slight cost consideration.

This investigation showed large-sized hydraulic couplings in an interesting stage of development. In the earlier designs, one half of the coupling had been mounted on the motor shaft and the other in a pedestal bearing with a thrust bearing between the two halves. A second development had removed the internal thrust bearing and substituted a special thrust bearing built into the motor bearing. The third and final design, existing on paper only at the time the order was placed, consists of two pedestal bearings, each with a thrust bearing. The shaft of one half extends through the hollow shaft of the other, with internal bushings. The whole forms a complete unit connected to the motor and fan with flexible couplings. This design and the development work were carefully reviewed and the unit was finally adopted.

The selection of boiler feed pumps was relatively simple since several designs were available, with good performance records. Edison experience with 1400-psi centrifugal pumps served as a basis for judgment as to the details. The pumps selected are of relatively small capacity, 400,000 lb per hr each at 3600 rpm, and complete spare capacity of 100 per cent was provided. Two are motor-driven and two turbine-driven.

Edison practice in piping had taken up welding gradually.

For many years the steam mains of the district heating system had been welded because their inaccessibility required the most permanent form of joint. In 1927 the economy of welding low-pressure condensate and bleeder-steam lines was recognized and employed at Edgar Station. In 1930 at Kneeland Street, one step further was taken, and boiler feed lines were welded. For the L Street installation, it was apparent that flanged joints for 1400 psi and 910 F were not well-standardized, although experience with sargol joints at 1400 psi and 750 F was satisfactory. A rough study of joint costs based on unit prices submitted by piping companies led to the following general conclusions: At low pressures flanged pipe is cheaper than welded pipe for the larger sizes. At high pressures welding is cheaper than flanging. Screwed joints cost one half as much as other types.

Welded construction among Edison neighbors appeared to be giving satisfaction. Therefore, it was decided to use welding as much as possible throughout the installation. Welding was indicated for the valves of high-pressure steam lines since the only alternative was seal-welded sargol joints at a greater expense. Low-pressure valves and most high- and low-pressure water valves were flanged since adequate joints were available for these services.

On the basis that remote operation is necessary and that the cost of the automatic feature adds little to the cost of remote controls and instruments, full-automatic combustion control was decided upon. In selecting the equipment, considerable weight was given to the measurement of fuel-air ratios by fundamental methods such as by meters for CO_2 or steam and air flow, rather than by feeder speeds and the like. The control selected is air-operated and the master "more or less" impulses come from steam pressure. Fuel feed is regulated directly from the master; the ratio of steam flow to air flow regulates the induced-draft fan, while furnace draft is regulated by the faster vane-controlled forced-draft fan. In this connection, the familiar discussion arose as to whether forced draft or induced draft should control furnace draft. With fans and controls of equal speed of response, it should be obvious that there is no choice in this matter, since both act in a simple series circuit. In this case, with the hydraulic-coupling-driven induced-draft fan considerably slower than the vane-controlled forced-draft unit, the argument was reduced to the question of whether it was more important to have the furnace draft or the total air flow correct under transient conditions. The decision was made in favor of the furnace draft, which regulates ignition and minimizes the occurrence of puffs of flame through access doors.

Superheat is regulated by a damper automatically controlled from temperature regulators in the leads from each boiler. These instruments are "mastered" by a third temperature regulator in the turbine exhaust, which protects the existing low-pressure equipment from excessive temperatures.

Temperature control and protection are further provided by the pressure-reducing and desuperheating equipment. The principal item is the large by-pass line which will by-pass 800,000 lb of steam per hr around the high-pressure turbine. This will function to supply low-pressure steam in case the turbine is tripped out or shut down. It is fully automatic, as the reducing valve is controlled by downstream pressure and the desuperheater by steam flow and downstream temperature.

A smaller by-pass is provided for low loads and to supply steam to the auxiliaries in case excess high-pressure steam is available.

Auxiliary desuperheating nozzles are provided in the turbine exhaust as a final guarantee that temperatures to existing equipment will not be dangerous.

The final piece of automatic-control equipment was made necessary by the close clearances of the 3600-rpm high-pressure boiler feed pumps. These pumps at full shutoff will overheat and seize in a few seconds. Since in the parallel operation of steam- and motor-driven pumps shutoff of a pump might frequently occur, by-pass control is required. Its primary function is to open a by-pass around the pump and thus keep the pump cool. This control must act rapidly, and it was considered best to have it actuated by the fundamental measurement of water flow to the pump. It was also desirable to control the discharge pressure of the pumps so that motor- and turbine-driven pumps would "parallel" and keep a stable, constant excess pressure for boiler-feed regulation. For this purpose an air-operated controller actuated by excess pressure is used to vary the turbine governors and to position throttling valves in the discharge lines of the motor-driven pumps. After having provided these two devices, the additional cost of a complete flow-ratio controller seemed small, and it was accordingly purchased so that the various pumps in parallel can be set to carry any desired fraction of the load.

Another piece of apparatus that gave considerable food for thought was the ash-handling system. Experience in the various plants, which has covered all types of apparatus, including pneumatic conveying, in a small way, proved that all of these methods require considerable hard work and could stand further development. This case differed from the others because of the large quantities of dry dust expected in the Cottrell precipitators. Investigations disclosed that Cottrell dust could be well handled pneumatically once it was started into the feeders. Further investigations disclosed that pneumatic handling even of the ashpit refuse was practical and offered advantages of accessibility for hand manipulation of clinker formation. Complete pneumatic ash-handling equipment was purchased; special care was given to make the hoppers steep-sided, and vibrators were provided where trouble was anticipated.

The ash-conveyer piping discharges through a centrifugal separator and bag filter to a cylindrical tile tank, which empties into ash trucks through a rotary mixer, in which water is added for dust control.

Throughout the design of the plant, an effort has been made to balance investments against operating costs. This is somewhat in contrast to the old principle that the best is none too good. The difference can be plainly seen in the power-plant building itself, where glazed tile of intricate pattern has given place to partitions of hollow tile. Stair rails are simple pipe railings instead of ornamental castings with brass rails. Money has been spent only where the earning power of the investment could be demonstrated.

One other contrast in the building should be mentioned, and that is the structural-steel frame. In the new extension, the progress of power-plant design gave heavier loadings due to more auxiliary equipment, dust catchers, deaerators, and the chimney which is supported by the building. In consequence it was economical to use a continuous steel frame, designed by the Hardy Cross moment-distribution method. This design, which permits the utilization of fixed connections between beams and columns, achieves economy by taking some of the moment in the columns, thus reducing the size of beams and girders. Since wind bracing was also eliminated by increasing the stiffness of connections, there are some unusually heavy connections in the steel.

This superposed unit is not yet in operation. The Company has confidence that an economical investment has been made because of experience at Edgar Station with similar units and because of studies similar to those which are discussed in this paper.

AERONAUTICS *and* NATIONAL DEFENSE

By IGOR I. SIKORSKY

VOUGHT-SIKORSKY AIRCRAFT, DIVISION OF UNITED AIRCRAFT CORPORATION, BRIDGEPORT, CONN.

THE VALUE of an air force for military purposes remained a controversial subject until very recently. Even when the civil war in Spain was well under way and we read the frequent reports of bombardments, skeptics were saying that although a big city was being repeatedly bombed from the air, it could not be forced to surrender. Of course, this criticism could be extended with the same amount of justification to the use of artillery in the war. Madrid was shelled by artillery from a short distance during the same time without causing its surrender.

Certain factors must be considered in connection with the aerial warfare in Spain. First of all, the air force was small in proportion to that of a modern military power. Franco had at the end of the war approximately 500 planes. Next, he unquestionably tried to spare the city of Madrid and some of the other valuable centers. In other words, he was limiting the use of air bombardment to a certain extent, which may not be the case if really hostile powers clash with each other. Still, in spite of this, it cannot be denied that the air force was one of the major factors that contributed to the victory of the Franco forces in Spain.

It is now known that a large number of successful bombardments took place, that scores of merchant ships, about 50 of them, were either sunk or damaged, proving for the first time that aircraft may be a serious instrument of blockade; probably more powerful than the submarine because it is much faster and more mobile, as well as less expensive. All this contributed to the success of the Franco forces. However, whether we agree or disagree with this conclusion, there is another point which cannot be denied—the outcome of the Munich conference.

I was in London at the time and in touch with several well-informed people. There seemed to be little doubt in London that the outcome of the Munich conference was not influenced by the importance of the German army or navy, because it was taken for granted that the so-called French Maginot line would be able to hold the German army for a long time, while the British fleet would control the seas. The outcome of the Munich conference was dictated by the tremendous expansion of the German air power and by the seriousness of war from the air.

NEW AIR ATTACK METHODS

It was mentioned that the Germans could send bombers at the rate of 50 per hour for many days. Fifty bombers could carry an average of 100 tons of bombs. Assuming that 500-lb bombs were used, this would mean about 400 bombs per hour. One of the methods of mass attack by bombs would be to drop them more or less in one line, creating an avenue of destruction. Imagine 400 bombs dropped at intervals of 125 or 150 ft from each other. The area of destruction of one of the bombs would intersect with the area of destruction of the next one and the total would represent a line about one mile long.

Presented at the technical session of the first annual "Spring Round-Up," April 20, 1939, of the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The bomb that would land on a street would make a huge hole, while the one falling on a building would send a large part of it into the street blocking all traffic. So, once a line is cut across the city, the passage of the fire brigade and of ambulances would be blocked, and other communication would be disrupted. The fact that this mode of attack could be repeated once every hour for several days would unquestionably represent a very definite menace. Neither London nor Paris would be wiped from the surface of the earth, even with such type of bombardment, but there is hardly any doubt that extremely heavy loss of life and property would result. More than that, life and work would become intolerable to such an extent that the activities of the city would nearly cease.

Again using the Spanish civil war as an illustration, I will mention a few interesting figures. General Franco at the end of the campaign had about one million men under arms and approximately 500 planes. In Germany, at the end of the first year of conflict, there would probably be an army two or three times greater and an air force about 50 times greater. This proportion for the army and air force shows why I feel that there would be a considerably greater influence of aircraft on the outcome of a war between great powers as illustrated by the results of the aerial warfare in the Spanish civil war.

GERMAN AIRPLANE-MANUFACTURING PLANTS

I have recently been through England and Germany and I must say that the statements we hear about the German air power are reasonably correct. I have visited several factories, one of them being the very impressive Heinkel plant near Berlin. Working reasonably slow this factory produced about two first-class bombers a day. Without adding equipment but working in several shifts the factory could probably produce five or six per day. Combining this information with the data which other Americans have gathered, it seems very feasible that the Germans at the time of my visit were producing something like 30 or 40 good war planes a day and could bring this number to probably 80 or 100 a day within a reasonable time in case of necessity.

All the factories are well-equipped with means of protection from air raids. For instance, the Oranienburg Heinkel factory is situated far away from any city or village, in fields and among forests of trees. There are some 20 huge buildings situated at a substantial distance from each other. No matter how well the bombs could be dropped, a large percentage would fall between the buildings. Near each of these buildings or adjacent to them are numerous subterranean air shelters. We were shown through a few of these and saw drinking water, food, medical supplies, gas masks; in fact, everything needed for an emergency. All the workers are trained and know where to go in case of an air raid. Upon hearing the siren, they lay down their tools, walk down into the shelter, stay there until the raid is over, and then go back to work. There are also special shelters for crews with automobiles and equipment to extinguish fires, to render medical assistance after a bombing raid, and to quickly repair damaged buildings, equipment, etc.

It would be difficult to seriously damage such a factory by aerial bombardment.

ITALIAN AIRPLANE FACTORIES

I believe that Italy ranks second in air power in the world. The airplanes there are being built somewhat differently. They are constructed mostly with wood-veneer wings and welded-steel fuselages, which means simple and inexpensive construction. The wood-veneer wings would not last long, but as long as they do they will perform just as well as the more expensive and finer wings built in Germany, Great Britain, and America. They are cheaper and are produced quicker and in larger numbers. In Italy, I have seen a factory in Milan which now produces about two bombers a day. According to the manager, the plant could produce eight a day within a week after the signal has been given to go ahead full speed and even more within a few months. In this factory, there is an assembly line similar to that of a Ford plant with the exception that the line is composed of a series of individual trucks on which the ships being assembled are mounted. A bell orders the men to stop their work, push the cars from one station to the next one, and resume work again. As a result, it is possible, if necessary, to increase the number of men and proportionately shorten manufacturing time, provided that at each station there are enough trained men.

A vast majority of the military airplanes produced in Europe are short-range planes that could not bomb objects situated at more than 750 or 1000 miles from their operating base.

But getting back to the topic, "Aeronautics and National Defense," is there any difference between defense and offense?

In Europe, there would be no difference because the types of military aircraft, as well as methods of aerial warfare, would be the same in a war of defense as in an offensive war. In both cases, squadrons of bombing planes would attack political and industrial centers, railroad terminals, bridges, etc., in the territory of the adversary, while pursuit and interceptor planes, as well as antiaircraft artillery, would attempt to destroy the invading bombers, or at least chase them away from the most important objects of attack. Besides, the air forces would fulfill various missions in connection with the activities of their respective armies and navies.

IS AMERICA SAFE FROM AIR ATTACK?

The situation is different with reference to the United States where two wide oceans separate us from any important potential source of attack. No matter what progress is made in the design of aircraft, to cross the ocean with bombs, armament, and enough fuel for a return trip would remain a serious problem for an attacking force. It might be possible, by using extremely efficient, long-range airplanes which could take off with bombs, be refueled, and take on board an additional load in the air, and then proceed across the ocean.

Reduced to facts and figures, the situation may be presented as follows: An average modern air bomber, costing $100,000, could carry 2 tons of explosives a sufficient distance to bomb most of the capitals of Europe from an adjoining country. During important periods it could repeat the raid two or three times a day. However, a large efficient plane, costing between one-half and one million dollars, would be needed in order to carry the same two tons of bombs across the ocean and to return to its starting point. In view of the difficulties, the necessity of refueling in the air after take-off, etc., the ship could hardly make more than one trip per week. Furthermore, the considerable fuel load carried would of necessity cut down the speed and climb of such aircraft, increasing, therefore, the chances for pursuit planes to bring it down when it reaches our shores after a long, 4000-mile transoceanic trip, still carrying on board the fuel necessary for a return flight.

An attacking air force would have better chances if it could succeed in secretly establishing intermediate air bases somewhere in Central or South America, or in Greenland. However, a location for such an airport could hardly be found at less than 2000 miles from any important center of the United States, which is still a considerable distance and, therefore, a great handicap. It would be difficult to send a large air force in this manner, but an air attack of such nature is possible and proper means of protection are needed. The type of aircraft needed for defense would be somewhat different from planes required for a war of offense. In case we would have to load our planes on ocean transports and ship them to some other continent, we would need smaller ships, identical with those in general use in Europe. For a war of defense we would need ships of larger size and longer range that could meet a possible enemy far away from our shores and that could efficiently patrol vast areas in Central and South America, or possibly around Labrador and Greenland in order to detect and destroy any intermediate bases that may be established secretly by some prospective adversary. Indeed, all types of aircraft in sufficient numbers are needed, but the geographic location places emphasis on the latter type of machine.

With respect to the danger of an air attack, this country has probably the best and safest geographic location as compared to any other country in the world. However, the great country and its people that must be protected and the necessity to maintain the proper standing in line with the importance of this nation, in my mind, fully justify the steps that have been taken by our government in order to bring the air power of this great country to the necessary size so as to be able to protect ourselves properly under any circumstances, even if something that we cannot foresee at the present time should happen.

S-42 CLIPPER, VOUGHT-SIKORSKY AIRCRAFT

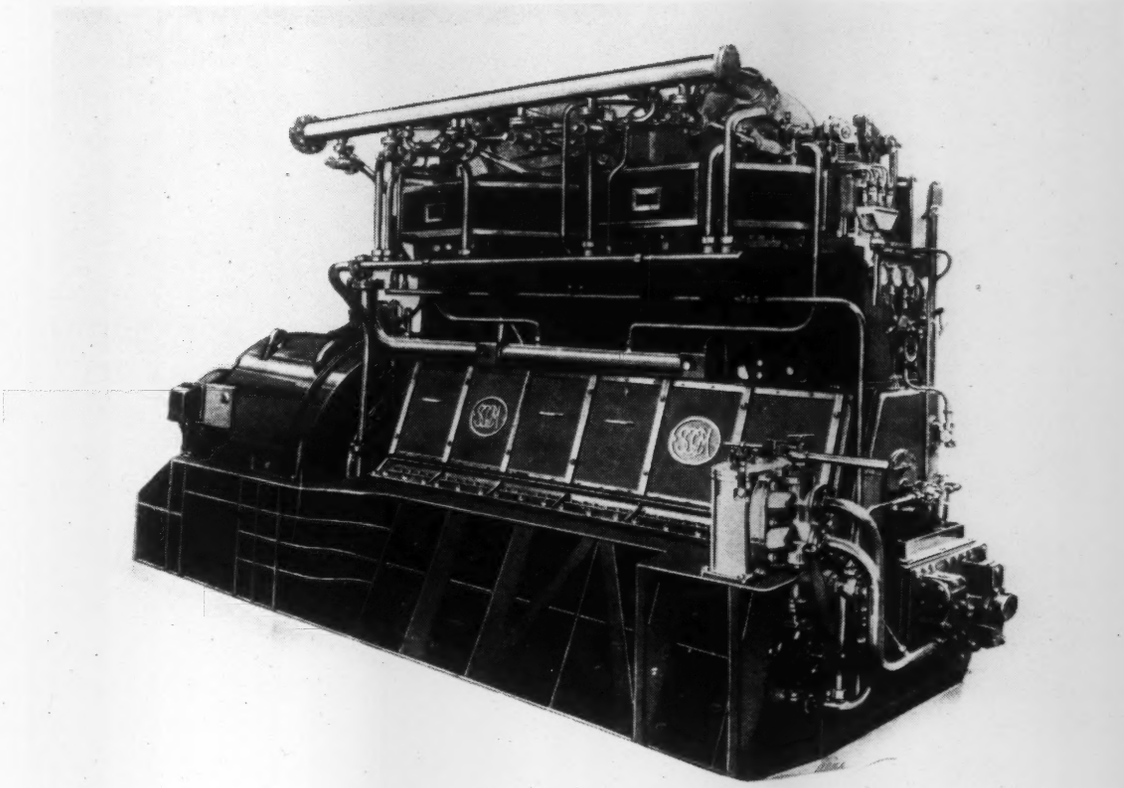

FIG. 1 M.A.N. DIESEL BY FRENCH LICENSEE
(Locomotive engine, four-stroke cycle, 700 hp normal rating, 950 hp supercharged.)

INTERNAL-COMBUSTION-ENGINE DESIGN IN EUROPE

By MARCEL BOCHET[1]

SOCIÉTÉ ALS. THOM, PARIS, FRANCE

SOME THIRTY years ago, European manufacturers designed Diesel engines that weighed more than 300 lb per hp and for average speeds, according to cylinder size, between 100 and 300 rpm. The air-injection system of atomization was used, that is, the injection was obtained by admitting compressed air to the fuel spray valve. The diffusion and penetration of the fuel were thus correct but the engine actuated a compressor which often took as much as 10 per cent of the power.

The weight of modern Diesel engines is now as low as 40 lb per hp for industrial and marine types and 10 lb per hp for those used on road and rail vehicles. These modern engines are fitted with solid-injection systems of various designs. Such important changes have been successfully obtained without much alteration of the former Diesel cycle, but the maximum pressure has been increased. Progress has been principally the result of the change of the injection device, improvement of the quality and treatment of materials, accuracy of the machining with modern tools, study of the combustion conditions, and increase of piston speed. Better balancing of higher-speed engines has also contributed to this progress.

EXAMPLES OF EUROPEAN DIESEL-ENGINE CONSTRUCTION

Reference to the literature shows that since the beginning of the century, the piston speed of Diesel engines has increased from 600 to about 1600 fpm in industrial engines and has sometimes reached 2400 fpm in automotive engines. As a result of these higher speeds, engine power per cubic inch of cylinder volume has greatly increased. Extensive experimentation has also been necessary to obtain, with solid injection, smokeless operation

[1] Chef de Travaux du laboratoire de Machines Thermiques de l'École Centrale des Arts et Manufactures, à Paris. Ingenieur Conseil à la Société Als. Thom, Professor à l'École Breguet et à l'École Francaise de Meunerie à Paris.

Presented at the National Meeting of the Oil and Gas Power Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, held at Ann Arbor, Mich., June 19–22, 1939. Abridged.

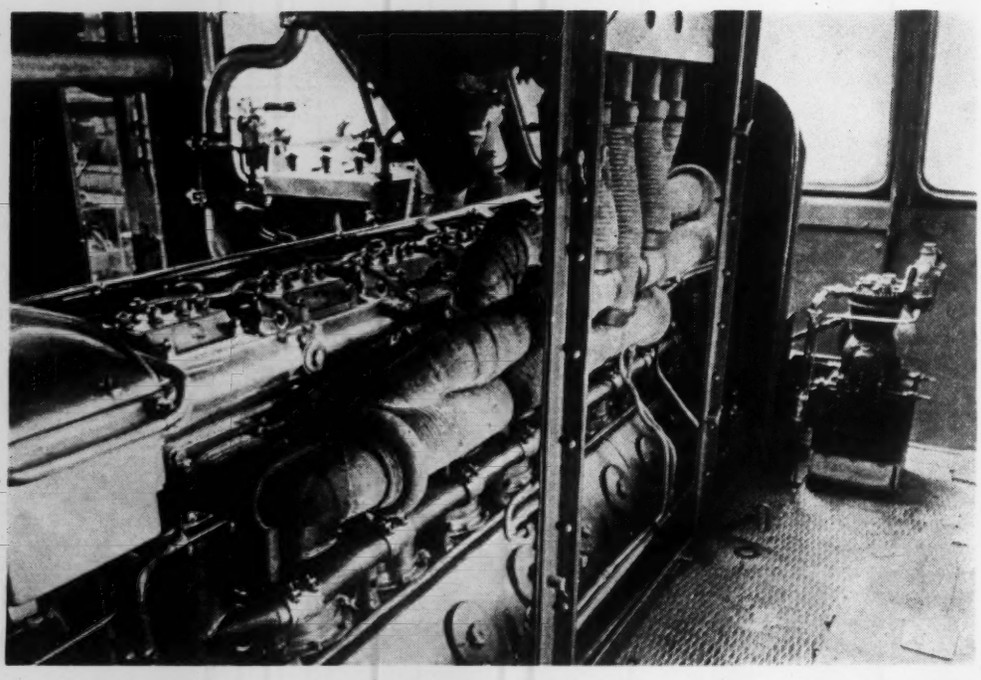

FIG. 2 M.A.N. RAILWAY DIESEL SUPERCHARGED WITH RATEAU TURBOBLOWER

at a mean effective pressure of about 70 psi, which had been reached long before with air injection.

Evolution of Diesel engines in Europe has exhibited about the same trend in all the countries of the Continent because of the many license contracts that exist among the various manufacturers. It is the purpose of this paper to describe some of the latest typical designs that have been the result of this evolution.

The Sulzer Company and its licensees have, during the last 20 years, reduced considerably the weight and size of the engines they build. A two-stroke, 4500-hp, 132-rpm engine, in 1915, was 46 ft long, the piston speed was about 900 fpm, and the weight, 370 tons (U. S.). The same company can now quote on engines of 10,000 hp at 170 rpm, with a piston speed of about 1240 fpm, a weight of 580 tons (U. S.), and length of 71 ft. The weight per horsepower has been reduced from 167 to 116 lb for the large sizes, and the engines have practically the same height notwithstanding the power difference.

Among interesting types, omitting submarine engines (the weight of which has decreased to about 44 lb per hp) some 11,000-hp engines for large power stations should be mentioned as well as the engines of the Diesel-electric locomotives of the French National Railways, South-East district. The latter consist, on a single frame, of a twin engine driving an electric generator through reduction gear. They are four-stroke supercharged engines with mechanical injection and develop 2200 hp at 700 rpm. The crankcase consists of cast-steel elements, electrically welded. The sump is made of welded sheet iron.

Other interesting Sulzer engines are those of the ZG, two-stroke, opposed-piston, horizontal type. They have small dimensions, are perfectly balanced, and weigh little for their power.

The M.A.N. Company, of Augsburg, and its licensees have developed new and interesting arrangements; for example, the large two-stroke, single-acting, marine engines that develop 2600 hp at 170 rpm and operate with mechanical injection. The piston speed is 1000 fpm and the mean-indicated pressure in regular service is 78 psi. The scavenging air is supplied by a rotary blower at a rather low pressure which is high enough because the ports are well located and the air makes a complete circuit in the cylinder. The ports are superposed on one side of the cylinder in such a way that the air is blown toward the wall opposite the exhaust, rises in the cylinder, and correctly scavenges the combustion space.

Among the latest types of the Société Generale de Constructions Mécaniques, a French licensee of M.A.N., should be mentioned the engines of the Congo-Ocean locomotives (Fig. 1) and of the French National Railways, South-East district. In both cases, supercharging is accomplished by a Rateau turboblower and a large increase of the power is thereby obtained. The mean pressure has been raised from 78 to 114 psi without noticeably increasing mechanical and thermal stresses because a good design has been adopted.

Accurate tests of the engines built for the French National Railways (which have cylinders similar to those of the Congo-Ocean Railway) have shown that with an increase of 700 to 950 hp by means of supercharging, the heat balance is affected as shown in Table 1. The amount of heat lost through the oil and cooling water was less in the case of the 950-hp supercharged engines than in normal operation and remained about the same when the output was 1050 hp.

The large locomotives of the French National Railways include two, twin, 6-cylinder engines on one crankcase and deliver about four times the power of the Congo-Ocean locomotives. These engines are connected to a direct-current generator by means of gears. Cast iron is used for the frame and the cylinder heads. The stiffness of the assembly is obtained by 14 steel rods which run through the frame from top to bottom and withstand, according to a design generally used by the M.A.N., the tension stresses set up in the engine. This design makes possible much lighter engines, the weight of which (frame, crankcase, and turboblower included) is only 17,400 lb.

M.A.N. and its licensees also build rail-car engines (Fig. 2) of ingenious design in which the cylinder liner, made of a steel sleeve surrounded by a welded water jacket, is removable. The cylinder heads are strongly assembled and, acting as a truss, have to be taken out only under exceptional circumstances. It has thus been possible to locate the camshaft in a longitudinal casing above the cylinder heads. Valve rockers are designed with a minimum of inertia and fuel pumps are located in the immediate vicinity of the injectors. Oscillations of the liquid columns ordinarily caused by elasticity of the pipe

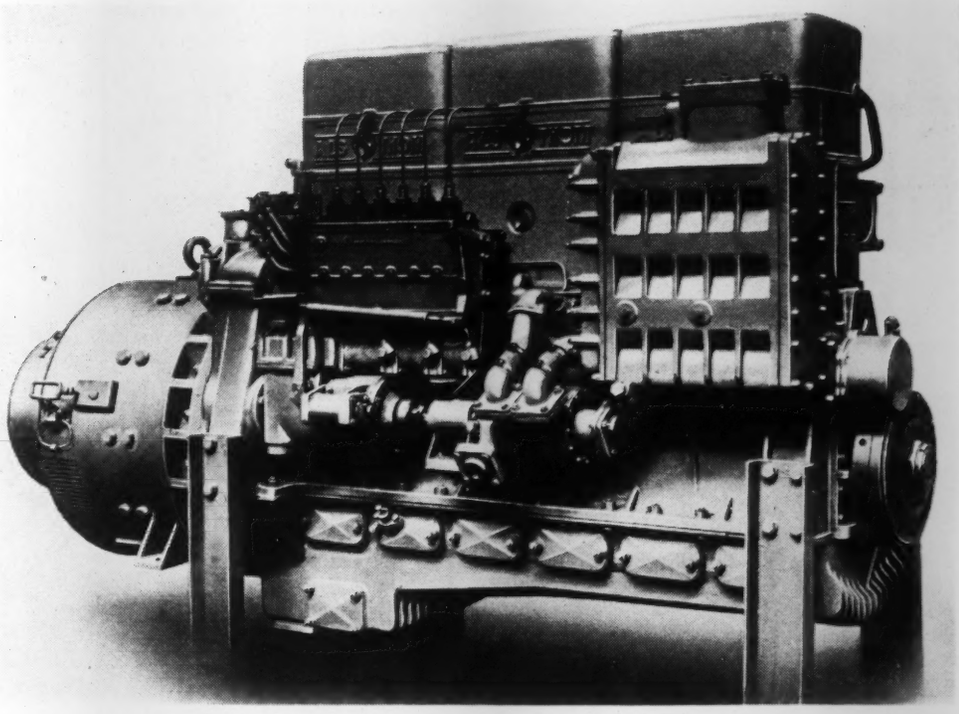

FIG. 3 HIGH-SPEED VIII JAR 150 DIESEL BUILT BY HUNGARISCHE GANZ CO. AND LICENSEES

are avoided. Each cylinder has two inlet and exhaust valves. The injector is at the center. This engine can be supercharged by a Rateau turboblower. For eight cylinders, there are four exhaust pipes, each connected with two cylinders at one end and to one of the four intake nozzles of the turbine at the other end. At full load, the blower compresses the air in the neighborhood of 0.44 psi in the inlet collector. The blower runs at about 9500 rpm.

TABLE 1 EFFECT OF SUPERCHARGING ON HEAT BALANCE

	Normal,	—Supercharged—	
	700 hp	950 hp	1050 hp
Useful power, per cent	36	38.1	36
Losses in oil, per cent	3.5	2.6	2.4
Losses in water, per cent	26	18	17.6
Losses in gases, per cent	32.5	39.7	42.5
Losses by radiation, per cent	2	1.6	1.5

The Burmeister and Wain Co., of Denmark, has concentrated its efforts during recent years on two-stroke engines with scavenging ports located at the lower end of the cylinder and piston or exhaust valves, according to the size, located at the upper end. Scavenging air is supplied by a rotating blower driven by the engine, and this uniflow system produces a complete filling of the cylinder, which insures high mean pressure. This system is used not only with large marine engines of several thousands of horsepower but also with light locomotive or rail-car engines.

Scandinavia has developed to a considerable extent the manufacture of Diesel engines and the fleets of northern countries consist more and more of Diesel-powered ships. An interesting feature of the Dutch Werkspoor Co. is the use of the bottom of the cylinder as a compressor to supercharge four-stroke engines. The piston rod runs through a gland as in a double-acting engine.

LIGHT HIGH-SPEED ENGINES

The VIII JaR 150 industrial-type engine (Fig. 3), built by the Hungarische Ganz Company and its licensees according to the Jendrassik system, has cast-iron pistons. Its rigid twin-cylinder blocks are fitted on cast-iron casings and are easily removable. The main bearings and the big ends of connecting rods are fitted with babbitted bronze. The pressure lubrication is supplied by a special pump located in the bottom of the sump. The oil, which is also used to cool the pistons, is directed by a small nozzle located in the upper part of the small end of the connecting rod in such a way as to assist in cooling the piston. Operation of the piston rings and the oil film on the cylinder walls is also improved.

In the VIII JmR 150 engine, which is suited to rail-car use, the general features are similar but the cylinder blocks are fitted upon a light metal crankcase and long steel rods run through the cylinder block to prevent tensile stresses in the cast-iron parts. The shafts are of very hard special steel, and short intermediate bearings are located between the cranks. The big end of the connecting rod is made long to transmit the forces as close as possible to the bolts of the bearing caps. The bearing lining instead of being subjected to the bending deformation which tends to open it, presses uniformly on the shaft in such a way that it better withstands the high unit pressures. The pistons are made of aluminum alloy and have oil-scraping rings to prevent excessive lubricating-oil consumption. The circulation is abundant and is under a higher pressure than in the industrial type of this engine. The valves of large cross section are controlled by rockers and, in the railway type, a special feature which consists of a counter lever resting on a flat plate of machine steel, the height of which is maintained by oil pressure, suppresses the clearance between lever and valve.

The Ganz engines are designed with a precombustion chamber which contains the greater part of the air at the end of the compression stroke and which, because of the arrangement of the openings, provides strong turbulence in the incoming air (Fig. 4). The pressure, which after the ignition forces the gases through the nozzles of this chamber, further improves the mixing of the air and of the fuel in such a way that it is possible to obtain high mean pressure without smoke. This design also makes these engines less sensitive to the value of the cetene index of the fuel, so that they can more easily oper-

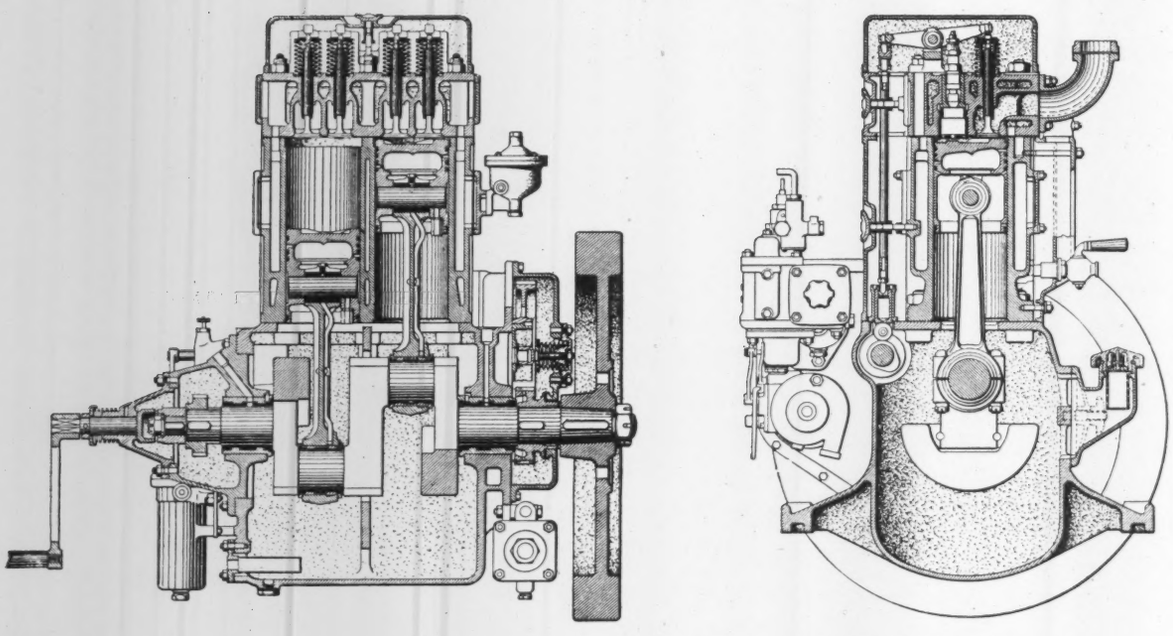

FIG. 4 SECTIONAL VIEWS OF ALSTHOM-GANZ-JENDRASSIK DIESEL, 1000 RPM

ate with various fuels. Fuel consumption is small. The VIII JaR 150 engine uses only 0.374 lb per hp-hr at its best rating. The fuel is atomized without a needle valve by open injectors with check valves which are much less complicated than are the usual needle valves and require comparatively little upkeep.

The use of open injectors does not affect the precision of injection since the pressure is adjusted by a calibrated spring which operates the piston of the fuel pump with a constant acceleration quite independently of the operating conditions of the engine. The injection cams merely move a lever which compresses the spring and the injection is controlled by a latch which trips the lever. This design, which resembles the control system of the tripped magnetos of gas engines, insures easy starting. It also provides a more constant volumetric efficiency of the fuel pump and a better division of the load between the cylinders.

The patented starting system with its mechanical air-preheating feature is important for engines which, like those for ships or vehicles, may be exposed for long periods to cold temperatures in winter. The sliding camshaft can be set in three positions. On the second, corresponding to the starting period, the inlet valve is shut and thus a vacuum is maintained in the cylinder during nearly all the suction stroke. Near its end, the inlet valve is opened, the air rushes into the cylinder and its temperature is thereby raised.

FIRMS PLAY LARGE PART IN DEVELOPMENT

Among the firms that played a large part in the development of light Diesel engines is the Renault Company which, after some trials, specialized in high-speed four-stroke mechanical-injection engines, designed for electrical generating sets and for marine and automotive use. A large number of these engines have been purchased by the French National Railways for rail cars. Most Renault engines are equipped for direct solid injection. The camshaft, which operates the valves by means of rockers, is carried on the side of the cast-iron cylinder blocks. Because of its long experience in manufacturing automobile engines, this company was able to design very light motors.

Among the most remarkable types is the V-type, single-crankshaft engine which, with 16 cylinders, can develop 500 hp at 1400 rpm.

The German Junkers Company and its licensees such as the Compagnie Lilloise de Moteurs in France, has also tackled the problem of light engines but has concentrated its efforts on improving the two-stroke, opposed-piston type. Notwithstanding some drawbacks in manufacture, this engine is easier to balance and has a more uniform torque than standard-type engines. In the latest types, the reciprocating scavenging pumps have been replaced by rotary blowers. The engine weighs only 13 lb per hp. The Compagnie Lilloise de Moteurs builds similar motors of relatively slow speeds for industrial and marine use.

By means of an ingenious design the crankshaft of the Saurer engines, built in Switzerland and France, is carried by roller bearings placed around the cranks (Fig. 5). The bending stresses are then reduced to a minimum and by the way the engine is shorter. Notwithstanding the use of cast iron a very light motor has been designed with six vertical cylinders; it develops 150 hp at 1500 rpm and a 12-cylinder V type develops 300 hp. The engines are of the four-stroke, solid-injection type with double turbulence.

The Berliet engines are also of the four-stroke solid-injection type. They are fitted with a Ricardo turbulence chamber which gives excellent combustion at all loads.

The Maybach Works, in Germany, specialize in the manufacture of light engines of the V type with roller bearings for the shaft and rods. The standard 420-hp engine, when used with Büchi-type supercharger, easily develops as much as 600 hp.

The German Mercédès Benz and the Swiss Ober Hansli Works also build light engines with precombustion chambers.

Designers of the Henschel-Lanova injection-type engine have retained the reserve chamber which is now seldom used by European manufacturers of high-speed engines.

Hesselmann engines should be mentioned because of the low compression necessary on account of the use of spark plugs for ignition.

The German State Railways have developed a twin, flat-type, horizontal engine with opposed pistons, which can be

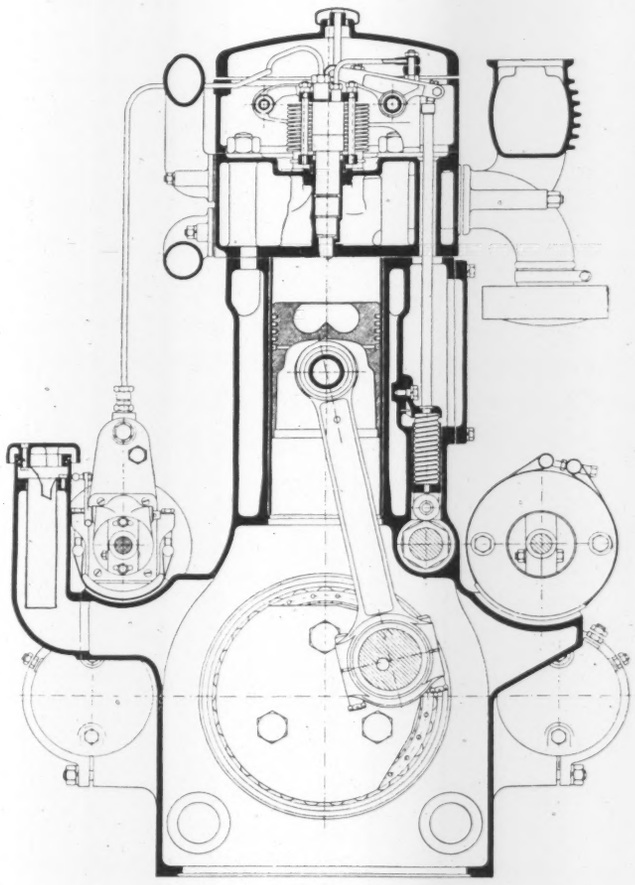

FIG. 5 SAURER DIESEL, TYPE BXD
(150 hp, 6 cylinders, 1500 rpm.)

easily located under a car frame. This engine has been built by several manufacturers. It is also built in France for railway use.

Many other European manufacturers build Diesel engines in which almost all of the features already mentioned can be found. A more detailed list is therefore considered unnecessary in this article.

INDUSTRIAL APPLICATION OF DIESEL ENGINES

Diesel engines have been developed to produce power in moderate-size stations. They are used either for direct drive with various types of couplings, or for driving electric generators.

The increased speed of rotation is particularly well suited to the drive of alternating-current generators. The number of poles can be reduced by the use of high speeds without impairing the life of the engines.

Among the most important power stations equipped by European manufacturers are the following: (1) The Copenhagen power station with a Burmeister and Wain engine of 22,000 hp at 115 rpm. (2) The Shanghai power station with Sulzer sets of various sizes, one of which develops 11,400 hp at 136 rpm. (3) The Hamburg-Neuhof power station with one 15,000-hp, 94-rpm, M.A.N. unit. (4) The Odensee power station with a 9000-hp, 125-rpm, Burmeister and Wain engine.

APPLICATIONS IN SHIP PROPULSION

Slow, long-stroke engines directly driving a propeller are used for ship propulsion. They are of the two-stroke or four-stroke type with superchargers.

Increase of piston speed and mean pressure has made possible reduction in weight and dimensions. During recent years a further step has been made by a more frequent use of higher-speed engines with reduction gears. These engines can be arranged in groups of two or four to drive a single line shaft through one speed-reducing gear in connection with several pinions. Hydraulic, electromagnetic, or friction clutches drive the propeller shafts. Selection of drive depends upon the power to be transmitted. Electrical transmission has also been used successfully in some cases.

The use of high-speed engines for ship propulsion will certainly undergo further development. The upkeep will be easier because of reduced weight of parts, handling will be easier, and inspections will be less expensive and require less time.

ENGINES FOR TRACTION PURPOSES ON RAIL AND ROAD

Engines used for traction purposes have been mentioned. They are connected to the wheels by means of mechanical, hydraulic, electrical, or pneumatic transmission. Mechanical transmission is used in Europe up to 500 hp. It consists generally of pinions always in mesh with a system of individual clutches. Electrical transmission is also much used, especially for large power, as for example for locomotives or multiple-unit cars.

The hydraulic coupling has met with some success in Germany but its use has been limited by its poor efficiency at low speed. On the contrary, hydraulic clutches are now frequently used. Pneumatic transmission has only been tried in some cases, especially by Deutz in Germany, but no definite results seem to have been obtained. Tests have been made by the Société Alsacienne de Constructions Mécaniques, in France, with free, opposed-piston generators of the Pescara type. Hot gases under pressure are supplied to cylinders similar to those of a steam locomotive and similarly connected to the wheels by rods.

DIESEL ENGINES FOR AIRCRAFT

European manufacturers have tried many types of Diesel engines for aviation use, especially in Germany, where Junkers engines are found in regular service. Junkers engines have opposed-piston cylinders and operate on the two-stroke cycle. The Jumo 205 engine has six vertical cylinders, 105 mm bore, with a twice 160 mm stroke, and a nominal power of 540 hp at 2000 rpm; its weight is 1145 lb.

The two-stroke Salmson-Szydkowski engine built in France is of a radial type with twin cylinders and common cylinder head. Its nominal power is 600 hp at 1600 rpm.

The French four-stroke engine of Coatalen's design consists of 12 cylinders in V design; nominal power is 500 hp at 2000 rpm.

The Clerget engine, also a French design, is made in radial-type units with 9 cylinders and in twin-radial-type units with 14 air-cooled cylinders. They have been used quite satisfactorily in service. The nominal power of the first type is 500 hp at 1900 rpm and that of the second type is 1300 hp at 1900 rpm.

The German Mercédès Benz Company builds 12-cylinder, V type, water-cooled, precombustion-chamber engines, which develop 800 hp at 1800 rpm, with a weight of 2060 lb. The crankcase is made of light alloy and the crankshaft runs in roller bearings. Similar engines are made by the Maybach Company for the Zeppelin airships.

Other types have also been tried, the characteristics of which are similar to those already mentioned. The use of auxiliary injection features which vaporize fuel before its admission into the working cylinder has also been tried by some builders.

DETERMINATION *of* PIPE-LINE VELOCITIES *in* BRACKISH WATER

By GEORGE W. HOWARD

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DETERMINATION of pipe-line velocities is of pertinent interest to engineers engaged in the handling of liquids, and numerous tests have been described in which various methods have been used. Best practice in hydraulic dredging, which is generally accepted, is the salt-solution method for determining velocities of clear water. The apparatus used has been described in detail in articles on the subject and in standard textbooks on hydraulics.[1] The remarks herein are concerned with the use of the apparatus in water in which the salinity was sufficient to preclude the use of the standard agent—a saturated salt solution.

During the period Jan. 14–23, 1937, the district engineer, Wilmington, N. C., conducted field tests on the dredge *Henry Bacon*. This dredge is of the cutter-suction type with 21-in. suction and 20-in. discharge pipes. At the time of the tests the dredge was working in the Savannah River, about 10 miles below Savannah, Georgia. This location is affected considerably by tides with a resultant effect on the salinity of the river. Investigations concerning the salinity of the Savannah River were made in 1935 by the Savannah Engineer District, and the results of these observations showed that, at the location of the dredge *Henry Bacon*, the salinity of the Savannah River varied from about 6000 ppm at low tide to about 30,000 ppm at high tide.

Although the primary purpose of the present tests was determination of the relative efficiencies of two types of discharge pipe, it was also necessary that velocities in the discharge line be accurately determined. The method generally in use for velocity determinations on hydraulic dredges is an adaptation of the salt-solution method, in that the time of passage of the salt solution is observed and timed with a stop watch rather than with a recording gage. Fig. 1 shows the arrangement of the apparatus used for these observations.

The salt-solution velocity apparatus depends for its operation on the detection of variations in the conductivity of the liquid as it passes the respective terminals.[2] It was necessary, therefore, to find an agent or chemical solution which, when injected into the pipe line in practicable quantities, would sufficiently change the normal conductivity of the mixture to cause a deflection of the milliammeter.

Tests were made in which eight different agents or chemical solutions were introduced into the pipe line and seventeen different concentrations were used. These agents and concentrations are presented in Table 1.

The first tests were concerned with a method for introducing a large quantity of the solution so that the upper part of the pipe—that in which the velocity terminals were located—would be completely filled with the solution. A 2-in. pipe was used in the initial tests for the introduction of the solution, but a change was made later to a pipe of 4 in. diameter in order to introduce the solution more quickly. Passage through the pump resulted in such a dilution of the agent that all of the initial tests failed.

Later tests were concerned with the introduction of a solution of sufficient conductivity so that diffusion would not prevent an indication on the milliammeter. This procedure was successful, as can be seen from Table 1 (tests with sulphuric acid).

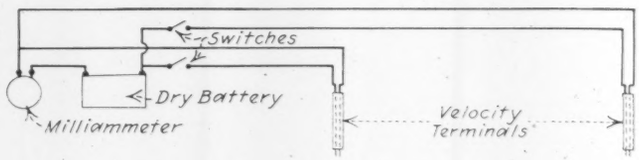

FIG. 1 WIRING DIAGRAM FOR OBSERVATION OF PIPE-LINE VELOCITIES

TABLE 1 AGENTS AND CHEMICAL SOLUTIONS TESTED

Agent or solution	Quantity, gal	Results	Remarks
Distilled water....	5	None	Mixing was evidently completely effected in passage through pump
Distilled water....	50	None	No reaction
Fuel oil.....	5	None	No reaction
Fuel oil.....	25	None	No reaction
Soda solution.....	5	None	1 lb soda per gal water
Salt solution.....	15	None	Saturated solution
Salt solution.....	30	None	No reaction
Lye solution.....	5	Slight deflection of needle	4 lb 14 oz of lye to 5 gal water
Lye solution.....	5	Slight deflection of needle	9 lb 12 oz of lye to 5 gal water
Copper - sulphate solution	5	None	2.5 gal saturated solution of copper sulphate and 2.5 gal water
Hydrochloric acid.	2	None	30 per cent solution
Hydrochloric acid.	3	None	No reaction
Sulphuric acid.....	5	Satisfactory deflection of needle	30 per cent solution
Sulphuric acid.....	2.5	Insufficient deflection of needle	Definite reaction but not strong enough for accurate results
Sulphuric acid.....	5	Satisfactory deflection	15 per cent solution
Sulphuric acid.....	5	Unsatisfactory	7.5 per cent solution
Sulphuric acid.....	1	Satisfactory deflection	Concentrated

DISCUSSION

The main problem involved in the tests with sulphuric acid was in the handling of large amounts of the solution. This objection was overcome by using a small amount of the concentrated acid instead of a large quantity of a solution. Direct connections from the suction pipe to a 5-gallon demijohn of acid reduced the hazard considerably (Fig. 2). In order to re-

(*Continued on page 534*)

[1] "Chemical-Electric Measurement of Water," by A. Barbagelata, Proceedings A.S.C.E., March, 1928.
"Applied Hydraulics," by Herbert Addison, John Wiley and Sons, Inc., New York, 1934.
"Hydraulics," by R. L. Daugherty, McGraw-Hill Book Co., Inc., New York, 1937.
"The Salt Velocity of Water Measurement," by C. M. Allen, Trans. A.S.M.E., vol. 14, 1923, p. 285. Also: "How Water Flows in a Pipe Line," by C. M. Allen, MECHANICAL ENGINEERING, February, 1934, p. 81.

[2] "Friction in Dredge Pipes," by J. H. Polhemus and J. R. DuPriest, Trans. A.S.M.E., vol. 49–50, 1927–1928.

ENGINEERING *and* PATENTS

By CHARLES E. LUCKE

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ENGINEERING, as defined by me in an article appearing in MECHANICAL ENGINEERING for November, 1926, is a profession and as such stands beside law and medicine. It is not a trade, though it is in contact with the trades. It is not a business, even though it has become a necessity to modern big business. Nor is it a science, though based on the exact sciences of physics, chemistry, and mathematics, and in its practice, the engineering method is essentially scientific.

Engineering is concerned with utility, with the creation of services and things for public use, especially new kinds, better, more useful, or more economical than were available before. All of the discoveries of scientific study and research are sought by the engineer as a possible basis for some new sort of product, some improved process, or some better public service. The development stage, from the conception, the way in which some betterment might be effected, to its commercial realization, and, in addition, the most economical handling of the new thing, is strictly the engineer's affair.

Excepting one division devoted to reproducing those things that have been proved to be useful, the essential element of engineering practice is the working out of improvements in machines, appliances, tools, and structures of all sorts, in methods of doing things involving all sorts of material, and in the use of energy in the form of heat, power, and electricity. The essential element of engineering procedure is design. Design begins with comparing the merits of the several alternative ways of accomplishing a result, and the selection of that one which is most suitable and most economical. It ends with the detailed planning of every step in the execution. The basis for design is found in engineering principles, which are the codified results of all past experience in making things and in doing things. This body of engineering principles is constantly being expanded with the accumulation of experience in engineering practice and in its interpretation, aided by special investigations and contributions of the related basic sciences.

Each new project becomes automatically an engineering problem, which always has more than one acceptable solution that can be developed by engineers trained in the understanding and application of engineering principles. Each solution is either an improvement or equivalent to a reproduction of some previous similar case. When the solution of the problem is an improvement, rarely is it wholly new. In nearly all cases the improvement is limited to some individual feature of the newly designed product.

An improvement worked out in the normal solution of engineering problems by engineers may prove to be an invention and, if so, may be patented by the inventor. This is the origin of most of the patents concerned with the products and methods of engineering, but at relatively long intervals there appear some patented inventions that are exceptions and not typical of engineering. To distinguish an invention from design is sometimes easy, but frequently it is very difficult because it involves an interpretation of engineering and also of patent law. This interpretation requires the services of specialists. It is still more difficult for those who are not specialists in these matters to distinguish invention from design, and the common error is to assume that a product to which a patent applies is as a whole an invention, when as a matter of fact the major part is usually an ordinary result of regular engineering design with perhaps only one feature that is a patented invention.

One of a group of papers presented at a Symposium on Patents, held in New York, N. Y., May 2 and 3, 1939, under the auspices of The Federal Bar Association of New York, New Jersey, and Connecticut.

PRODUCTS OF ENGINEERING

A large part of the products of engineering belongs to classes of power-generating equipment and power-utilizing machines, including vehicles for transportation on land, water, and in the air, which are characterized by simultaneous generation and use of power. Stationary machines and apparatus for processing are the heart of all manufactures, one class being machines for making machines—machine tools. Power-generating equipment includes all of the so-called prime movers with their auxiliaries; the steam engine and steam turbine, each with steam boilers, and the internal-combustion engine, all utilizing the heat of combustion of fuel, and the hydraulic turbine, utilizing the energy of water flowing from a high to a low level. It has often been said that modern engineering really began with the Watt steam engine because power generation as a branch of engineering practice grew directly from this. Availability of power stimulated the development of power-driven or power-utilizing machines, the earliest being pumps and textile machines. Both created a demand for better tools to produce them—also power-driven. In all of the series of improvements in products and services that can be traced from this starting point, there have been many thousands of patented inventions, only a small fraction of which have been useful. Of equal and perhaps greater importance is the steady growth at an ever-increasing rate of the body of engineering principles through which design becomes possible and improvements made available, independent of patented inventions.

In spite of the changes that have taken place since the time of Watt, there is much that is common to that time and the present; the differences are mainly in degree.

WATT AND HIS STEAM ENGINE

The Encyclopedia Britannica says that Watt was "the inventor of the modern condensing steam engine." It is common to find statements to the effect that Watt invented the steam engine. The general public seems to like to identify an inventor's name with almost everything and regards every improvement as an invention. Who invented the locomotive, the steamship, the airplane, the gasoline engine, the automobile, etc.? The answer of course is that no one invented such things, they are always largely products of engineering design, in spite of the fact that anyone may incorporate hundreds of parts which are patented, all of which may be applicable to other products. A product may include many patented features and be no invention itself. This is usually the case.

There were other steam engines with their accessories, boilers, pumps, auxiliaries, and connections before Watt; so it is clear that Watt did not invent the steam engine. He did, however, invent something under the British law, because patents were granted to him, and he did not succeed in producing his engines or steam power plants to make them available to users until after the patents were issued.

Referring again to the Encyclopedia reference, the best of the steam engines then known, that of Newcomen, was used as a

mine pump, but "it was so clumsy and wasteful of fuel as to be but little used." Watt undertook to improve it. The result was an engine, or rather steam power plant, that more people could afford to use, and so a demand for it was created, which in turn called for improved tools to make it. The improvements included a double-acting piston instead of a single-acting one, with a stuffing box for the piston rod and packing for the piston; valves for both steam admission and exhaust; a valve-actuating gear with a centrifugal governor; and a connection from the exhaust port to a separate condenser. Previously, condensing water had been injected into a single-acting cylinder supplied with steam at about atmospheric pressure. These improved features made higher speed possible, and also the use of higher-pressure steam, which together reduced the size and cost per horsepower of capacity. They also reduced the wastage of steam through cylinder condensation and leakage, which, together with the higher pressure, had the effect of reducing fuel consumption and operating cost per horsepower-hour.

To perfect these improvements required time and money repeatedly for experimental construction, for testing, and for interpretation of test results. This impoverished Watt, but after having secured a patent, he acquired a shop-owning partner for a two-thirds interest in return for the paying of expenses. This partner failed, and another shop-owning partner took his place, after which development of improvements continued indefinitely, with increasingly steady production. An act of Parliament had extended the life of the patent for 25 years, to protect the partners against competitive copying and to give them an opportunity to recover the expense of development and to earn a profit.

This story of the Watt improvement of the steam engine and the part played by patents has been repeated time after time and the same sort of thing will continue to happen. The differences are mainly in the part played by engineering principles as a basis for design, which in Watt's time was relatively small, and now is relatively large, in comparison with the inventive part. A difference of degree but not of kind, as to design and invention, is one effect of time, but there is another change. In Watt's time there was substantially no competition, while today, competition exists everywhere in the production of everything; and if not, it soon will.

PATENTS AID IMPROVEMENTS

Development of an improvement by one producer in competition with another may have the effect of causing another improvement to be made. If the first improvement is patented a competitor is forced to utilize engineering services to design something to equalize competition. This can always be done if the engineering staff is adequate and provided with the necessary facilities. The result is another contribution to public welfare. If this has patentable features, the process of competitive improvement through engineering design is repeated under the compelling force of patent protection, which prevents one from copying what another has created. Engineering can now give assurance of development of improvements in any product or process, quite independent of patentable features. This in itself promotes competitive effort, but when patents are secured, such competitive effort to make improvements is more certain and may be a necessity to continued existence of a competitor.

Thus systematic improvement, first by one and then by another, in a sort of zig-zag fashion, is perpetuated through engineering, patenting of inventions, and competition between producers. All three factors must be present if the public is to benefit to the maximum degree.

The importance of the patent factor in this set of three cooperative essentials of assured progressive improvements must not only be recognized, but efforts must be made to make it as effective as possible. This can be done through our patent system. The primary feature of the American patent system is, and always has been, the grant to an inventor of the exclusive right to make, use, and sell his invention, and administrative provisions are made not only for the issue of patents, but also for the protection of the exclusive right or monoply granted to the inventor for a definite period, now 17 years.

My own experience of about 40 years as a mechanical engineer on problems of improvements of processes, machines, and related equipment for individual and corporation producers, has convinced me that our patent system is a good one in all major respects. This does not mean that it cannot be improved, but it does mean that in any effort to improve it, such as now is under way, great caution must be exercised to avoid harm to those major features that have proved to be good.

Nothing should be done to impair or weaken the protection offered by a patent or the exclusiveness of the rights of the inventor. Some of the proposals made for changes in the patent system must be classed as bad and harmful on this basis. An example of this is compulsory licensing, which amounts to nothing more than legalization of copying by competitors, even if a royalty is paid, and in effect so devalues the patent as to make its issue an idle act, and a useless expense. The competitor should be forced to develop his own improvements by engaging competent engineers. Strong patent protection will have this effect, and the public will have two improved products instead of one. Moreover, without assurance of the patent protection, and for a sufficient length of time, there will be no incentive for the development of the first improvement. Thus the case will be, no patent protection, no improvement; adequate patent protection of a first improvement, then a second, a third, and a whole series of improvements. There are proposals other than compulsory licensing that would operate similarly to weaken the protection of the patent, or the rights of the inventor in its ownership. Lack of time prevents their consideration, but to all of them the same conclusion applies, their effect will be bad, and they must not be accepted because they are not in the public interest.

Among the rest of the proposals being considered for improvement of the patent system, some can be classed as definitely good, because they would contribute to the promotion of improvements available to the public, largely by better protection of the patent and its inventor. Most of these may be classed as administrative. These include rules or procedures that would insure more thorough weighing of prior art and improve the validity of claims of patents as issued, reduce the time of prosecution between the dates of application and issue, insure more competent consideration and convincing adjudication of the merits of patent questions in suit, and shorten litigation time.

CONCLUSION

In conclusion, attention must be focused on the fact that the situation under discussion is that in which engineering plays a part, and that the relation of patents to other things or activities may not be and in some cases definitely is not the same. The outstanding characteristic of the engineering-patent relationship is that a patent to the inventor of one improvement does not deprive the public of a benefit even if the owner of the patent elects not to incorporate his improvement in a marketed product. But, on the contrary, engineering provides the means whereby other noninfringing improvements may be developed. So a patent stimulates improvements by competitors who wish to remain in business. It must again be said that engineering, patenting of inventions, and competition between producers are cooperative agencies in the public interest. The stronger the patent and the inventor's ownership rights, the better for all.

The GREATEST *in the* WORLD[1]

The Engineering Societies Library of the United Engineering Trustees, Inc., New York, N. Y.

By A. R. MUMFORD, NEW YORK, N. Y.

CHAIRMAN, ENGINEERING SOCIETIES LIBRARY BOARD, MEM. A.S.M.E.

IN THIS city of superlatives in which we find the tallest building in the world, the greatest utility system in the world, the greatest subways in the world, and the greatest people, it is no surprise to find the greatest engineering library in the world. Our guest of honor, William S. Barstow, has been associated with many great things, not the least of which is your Engineering Societies Library.

WHAT MAKES THE LIBRARY GREAT?

It is said that a prophet is not without honor except in his own home. So with your library. The average member of the four founder societies takes the library for granted. The assistant state librarian of Canberra, Australia, however, told me the other day that he had come half way around this earth to see your library because of its fame as an outstanding example of a specialized institution.

What makes this greatness?

Is it the 160,000 volumes which if placed side by side on a single shelf would be as long as you could walk in one and one-half hours—briskly?

Is it the growth which has averaged two volumes every three library hours for the past twenty-five years and totaled 100,000 in that period?

Is it the 1200 magazines which currently come to the library each year and came during even the worst years of the depression?

Is it the ten thousand dollars worth of books which comes free to the library each year in return for the reviews written by its director?

Is it the eleven incunabula, books published before Columbus discovered America, or the 100 volumes printed between his discovery and the visit of the *Mayflower*?

Is it the fact that more engineering books printed prior to the secession of Texas from Mexico are available in your library than in any other?

Or is it the alloying of all these with the farsightedness of such men as our guest of honor?

Latimer Clark's collection is here. This is one of the two greatest collections known in the field of electricity, magnetism, and electrical engineering. This was given to your library by Schuyler Skaats Wheeler. The other, the Ronald Collection, is in the library of the Institute of Electrical Engineers in England.

General Electric and Westinghouse gave us 9000 volumes on electrical engineering.

Horace Vaughn Winchell's great collection on mining was given us by the Anaconda Copper Mining Company.

Curiously enough the first technical book written in the western hemisphere was translated from English into German for publication. It is represented by a collection of editions of Barba's Arte de Los Metales.

Conservatively, your library, if not now the greatest collection of engineering books in the world, is the solid foundation for such a collection.

In these days of low money rates, how pleasing it is to know that your library has grown at the rate of 6 per cent compounded. This growth indicates a virility which must be pleasing to those who realized the need for such an institution.

An average of 150 persons of firms use the facilities of your library each day. The information so gained helps to develop projects which undoubtedly give employment to many of our profession throughout the world.

When you look at the face of your watch it tells you the hour. You don't worry about the works. The library reading room is its watch face. You ask the question at this point and get the answer. Two floors of bookstacks back up the reading room and are made available to you by a corps of experts. A search, a translation, a photostatic copy, or a bibliography, all are readily available. On minor matters no charge is made to members. On the larger matters, however, service is available at cost.

FOUNDER ENGINEERING SOCIETIES REPRESENTED ON LIBRARY BOARD

The organization set up to administer your library consists of a board representing the Founder Societies and the United Engineering Trustees, Inc. It meets three times each year. Its executive committee, consisting of four board members and the chairman, meets each month. The library is under the immediate control of its director, Dr. Harrison W. Craver. Reporting to him are four departments: acquisition, cataloging, reference, and service. Dr. Craver has successfully merged the original libraries of the Founder Societies into a useful tool. His problem was as great and as involved as is the merging of companies. His success is attested by the world-wide appreciation of the standing of your library.

Sometimes comic relief is unwittingly supplied by such people as a lady who asked, "How much does a feather weigh?" When asked, "What kind of a feather do you have in mind?" she answered, "Oh, a little white curly one." Then there was the gentleman who asked, "How many miles in a degree?" When he was told that this might vary with the section of the earth, he became irate and blamed the library for showing off. Not many requests of this character are received. Most requests are from engineers who are deeply appreciative of the help they receive. Some, rightfully, we think, believe they should receive more help.

GREATER LIBRARY SERVICE HAMPERED BY LACK OF MONEY

At each of our Board and Executive Committee meetings of the last three years, one subject has always been discussed: How can the library be made of greater service to the engineers? Just as regularly the answer has developed—when we have more money. Strangely enough the library cannot be

[1] An address delivered at a dinner, May 15, 1939, at the Lotus Club, New York, N. Y., in honor of William S. Barstow and in appreciation of his interest in the Engineering Societies Library.

operated without funds. About $50,000 is now spent each year. Some of that comes from a permanent endowment of $200,000, which ought to be two million, and the rest from appropriations from the membership dues of the Founder Societies.

We want to serve the remote member more fully. We want to publicize the availability of library services without fear that the demands will cause us to exceed our budget allotment. These goals have been our aim. What progress we have made has been with the advice and aid of such men as our guest of honor.

MR. BARSTOW'S SERVICE TO LIBRARY BOARD AND TO ENGINEERING

We are gathered to honor him as an engineer, as a pioneer with Thomas Alva Edison, and as a member of your Library Board.

His record may be read in the growth of the utility industry, in engineering accomplishment, and in his recognition of a debt to the profession.

He has recognized by his active support of the American Institute of Electrical Engineers that the presentation and discussion of advances such as the topping turbines at Waterside permit the rapid dissemination of the knowledge and the further advancement of the art.

He has recognized by his full support of such media as the Edison Institute that the exchange of information among those active in the profession is of greater value the more widespread it becomes.

He has recognized by his support of institutions of higher learning, such as Stevens, that the coming members of our profession need the inspiration of the older members to carry on the traditions.

His activities as head of the Edison Pioneers have resulted in the collection of much of the material with which Edison worked and in the erection of the monumental lamp at Menlo Park.

In furthering the interests of the profession, he has fully and actively supported the work of your library. He knows that the availability of the record of accomplishment from Newcomen through James Watt, Corliss, and Parsons, to the record of the next step upward in boiler pressure not only makes it easier for those active in the profession today to take full advantage of the experiences of their predecessors but also that the younger members of our profession may use that record as a springboard from which to leap to greater and greater accomplishments.

Your library provides a technical service not matched elsewhere. With the help of such broad-visioned men as our guest of honor it is slowly extending that service. Through all his life he has recognized that the advancement of the profession both practically and ideally affords as great satisfaction and is as necessary to progress as the completion of an ultramodern efficient generating station. We, of the Library Board, think of him as our friend and mentor, vitally interested in the advancement of the profession through library services. We associate him in our minds with such men as Edward Dean Adams, Andrew Carnegie, Latimer Clark, James Douglas, Frederick D. Herbert, James H. McGraw, H. de B. Parsons, Oberlin Smith, Ambrose Swasey, Schuyler Skaats Wheeler, J. G. White, Horace Vaughn Winchell.

As these men have been friends of the library and, through the library, of the engineering profession; so our guest of honor tonight, is a friend of the library. It is with the satisfaction of recognizing true friendship that your Library Board has invited you tonight to honor him, as a man and an engineer, and a friend of the library.

Pipe-Line Velocities in Brackish Water

(Continued from page 530)

duce the possibility of acid burns further, operators were required to wear rubber gloves, and an antiacid solution was kept available at all times. (The acid was used successfully throughout the entire testing period without any resultant burns.) From observations made during the tests, it is believed

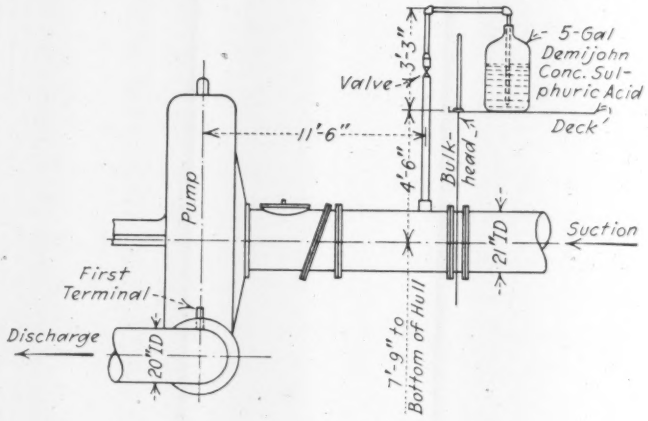


FIG. 2 ARRANGEMENT FOR INJECTING ACID INTO PIPE LINES OF DREDGE *Henry Bacon*

that better results could have been obtained by installing a pressure-injection apparatus for the agent on the discharge side of the pump. By locating this injection apparatus just ahead of the first terminal, the diffusing effect of the pump would be eliminated and larger deflections of the milliammeter could be obtained with the same or possibly a smaller quantity of acid.

Of particular interest in connection with the use of sulphuric acid is the increase in conductivity as compared to that of the ordinary saturated salt solution used for tests with the apparatus in clear water. Values of the conductivity of standard solutions in reciprocal ohms per cm are given for salt and sulphuric-acid solutions in Table 2. The chemical reaction resulting

TABLE 2 CONDUCTIVITY OF STANDARD SALT AND SULPHURIC-ACID SOLUTIONS

	0 C	10 C	20 C	30 C
NaCl	0.1345	0.1779	0.2259	0.2774
H_2SO_4	0.5184	0.6408	0.7645	0.8860

(From "Handbook of Chemistry and Physics," by C. D. Hodgman and N. A. Lange, 13th edition, Chemical Rubber Publishing Co., Cleveland, O., 1928.)

from the introduction of the acid into the pipe produced hydrochloric acid, as follows:

$$H_2SO_4 + 2\,NaCl \leftrightharpoons 2\,HCl + Na_2SO_4$$

It is not believed that the conductivity of the hydrochloric acid was measured with the instrument, because only a small amount of sulphuric acid was necessary for reaction with the weak salt solution. It is, therefore, most probable that the greater portion of the sulphuric acid was not used in the reaction and that it was the conductivity of this solution which was registered by the needle of the milliammeter.

ACKNOWLEDGMENT

The tests described herein were conducted by the Wilmington Engineer District of which Major Ralph Millis, C.E., was then district engineer. P. M. Snell, senior engineer, was in general charge of the tests which were under the direct supervision of D. A. Gardner. Major D. L. Neuman, C.E., R. Y. Newell, and the author, served as consultants during the tests.

MATHEMATICAL FORMULAS *as* AIDS *to* BUSINESS CHOICES

By OLIN INGRAHAM

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROF. WALTER RAUTENSTRAUCH has given too wide a title for the contents of his new book,[1] "The Economics of Business Enterprise." That part of business enterprise in which choices have to be made between alternatives that cannot be reduced to precise quantitative units is ignored. Labor relations are ignored. The colorful aspects of marketing are ignored. These fields do not supply neat little units which can be parts of algebraic formulas. What then is this book? It is mainly accounting, cost accounting, and budgeting.

It starts out with the panorama of the "economic cycle" within the single business unit, of money changing into goods that change back into money with the desired profit. It continues with chapters on the "principles of estimating costs" and the "methods of estimating costs." To me they are both chapters of methods. The later one has interesting sections dealing with the determination of the best lot size and with "Kelvin's law." The original case of Kelvin's law was the diminishing leakage of electricity with increasing diameter of the copper wire. More current could be sold but at greater cost of the wiring system. Similar instances could be given as to the determination of the proper heights of skyscrapers; the added rents made possible by the added cost of buildings. Now the economist generalizes this. He argues that the right amount of the production of everything tangible and intangible is limited by the point at which the expected extra net receipt is equal to the expected extra net cost. The so-called Kelvin law the economists consider the universal standard, a standard sometimes difficult to apply under the crude and uncertain conditions of economic life.

We pass to the chapter on interest and depreciation. The author deals with the price level and depreciation. There is the quite striking chart showing for the United States Steel Corporation the rising depreciation accounts in dollars from 1902 to 1925, against the horizontal depreciation accounts if the dollars are divided by price levels. Perhaps more pertinent would be a depreciation in terms not of the general value of the dollars, but of replacement costs in each industry.

The author goes on to the long list of methods used in calculating depreciation with their appropriate formulas. But these methods seem to the economist mere rule-of-thumb, with precious little interest shown in which method represents most nearly true depreciation. Take the method most commonly used—the straight-line method. The author quotes at length from the investigation of Prof. Wyman P. Fiske and William Gardiner Barker of current practices in accounting for depreciation. They sent out questionnaires to 510 concerns and received 215 usable replies. Of the 215 concerns, 178 used straight-line time. Now under what conditions would straight-line time represent true depreciation? True depreciation to the economist is the amount of the decrease in value of the asset from one accounting period to the next. Value to the economist is the summation of estimated discounted net services that the asset will contribute in the future. Would the straight-line method fit the case of the "wonderful 'one-hoss shay'" that contributed uniform services through 100 years? It would, and only would, if the discount rate were zero. Or let us put it more generally. The straight-line method is justified and only justified if the expected decrease of net services per year in future years is no greater than the rate of discount. With wear, tear, repairs, obsolescence, is it conservative for any business man to make such an assumption? Of course a crude way of meeting expected decrease of net services in the future is by assuming for purposes of calculating depreciation a life of the asset shorter than is probable.

Otherwise, some method such as the diminishing-balance method used by only 5 out of the 215 usable replies would approximate much closer to true depreciation. It may be claimed that that method might not be easily accepted by the income-tax appraiser. It is suggested that if the reasons given for the use of that method are no more pertinent than the reasons given by Rautenstrauch and others, the tax assessors should be excused for being obdurate. The reasons given by Rautenstrauch never reached the problem of the change in value of the asset.

In 9 of the 215 cases, depreciation is calculated on a unit-of-production basis. During the depression this would give very different amounts of depreciation than the straight-line method. That units of production measure roughly wear and tear and that wear and tear is a factor in decrease of value is admitted. The much more interesting question is whether units of production are roughly a measure of obsolescence. Certainly the orders for machine tools parallel the amount of industrial output. If we call real obsolescence the conditions under which a new machine will be substituted for an old one, this will be measured more by output than by time. Also the interest rates and discount rates move up and down with the total of industrial output. Therefore units of output may better measure their total cost than time. Of course this will apply only to the industries that move up and down with the average of other industries.

With interest and depreciation added the author can continue the estimation of costs in the chapter on the "economic worth of machines, materials, and supplies," supplying many interesting methods of calculations for many different situations.

From this he proceeds to a chapter on the break-even charts. The device is of interest in measuring costs against receipts of the single company at different levels of output. It illustrates beautifully the risk of large overhead or other fixed expenses. The economist would like another curve added, the curve of the amount expected to be demanded at different prices. Perhaps this curve is not added because of its relative uncertainty to any single businessman.

The next chapter is to me the most interesting of the book. There he plots the results of investigation in some of the large companies as to the relation between receipts and costs over a

(*Continued on page 538*)

[1] "The Economics of Business Enterprise," by Walter Rautenstrauch, John Wiley & Sons, Inc., New York, N. Y., 1939.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

THE A.S.M.E. MEDAL

A.S.M.E. HONORS AND AWARDS

VIII—The A.S.M.E. Medal

THE American Society of Mechanical Engineers established in 1920 its highest award, the A.S.M.E. Medal, which is awarded annually for distinguished service in engineering and science. The purpose in the establishment of the gold medal was that through its award the Society, representing some 20,000 engineers and engineering students, might give recognition not only to outstanding engineering achievement, but also to achievement in science which is capable of application in engineering fields. Through the years, the world's engineers and scientists have come to regard the A.S.M.E. Medal as a reward of merit which ranks among the highest in the scientific field.

The A.S.M.E. Medal, even though awarded in 1922 and 1923, was not available for presentation until 1925 when the Council commissioned James Earl Fraser, the well-known American sculptor, to execute the design. The obverse of the medal contains the name of the Society in relief lettering and depicts a full-length figure representing the engineer, who is holding the reins of industry in his left hand and the torch of knowledge in the other hand. This figure is placed against a background showing the sun shining on a typical industrial scene. On the reverse is the seal of the Society with the motto, "Give Me Where to Stand and I Will Move the Earth," inscribed around it. Each medal also carries, in raised letters on the rim, the name of the recipient, the date of presentation, and the citation for the award.

Candidates for the award may be nominated at any time by any member of The American Society of Mechanical Engineers by presenting to the Committee on Medals of the Board of Honors and Awards the name of an engineer or a scientist whose accomplishments have been in the field of engineering together with a full statement of his achievements. After considering and checking the qualifications of all candidates, the Board, acting on the recommendation of the Committee, sends its nomination to the Council for approval. Usually, the medal together with an engraved certificate is presented at the Annual Meeting of the Society. A recipient does not have to be a member of the A.S.M.E.

The eighth of a series of articles prepared under the direction of the Board of Honors and Awards of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, better to acquaint the members of the Society concerning the honors and awards which are given in recognition of meritorious achievements of engineers.

MEDALISTS

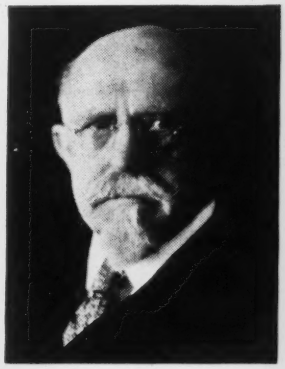
The roll of medalists contains the names of eminent engineers and scientists who have rendered distinguished service in their chosen fields of endeavor, such as management, manufacturing, physics, power generation, engineering design, machine tools, lubrication, air conditioning, optics, and marine construction.

FREDERICK ARTHUR HALSEY, member A.S.M.E., was the first recipient of the A.S.M.E. Medal in 1922 for his invention of the premium system of wage payments, which was publicly described for the first time in a paper presented before the Society at the Providence Meeting in 1891. This method was the first scientific system of wage payment, and, even today, is still effective in harmonizing the relations between the worker and the employer.

JOHN RIPLEY FREEMAN, president of the A.S.M.E. in 1905, and elected to honorary membership in 1932, was awarded the 1923 A.S.M.E. Medal for eminent service in engineering and manufacturing by his meritorious work in fire prevention and the preservation of property. His activities in the development of a system of rules and inspection for insurance companies has saved industry millions of dollars.

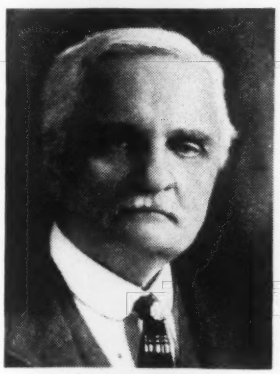
ROBERT ANDREWS MILLIKAN, winner of the 1923 Nobel Prize in physics, and director of the physics laboratory of the Cali-

F. A. HALSEY

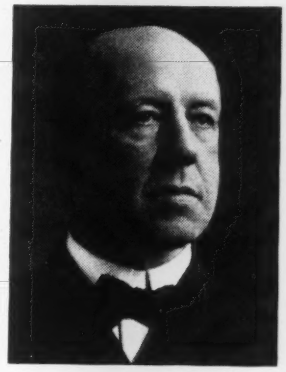


JOHN R. FREEMAN

R. A. MILLIKAN

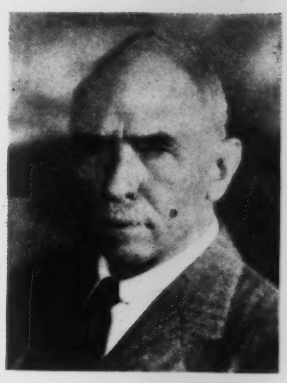


WILFRED LEWIS



JULIAN KENNEDY

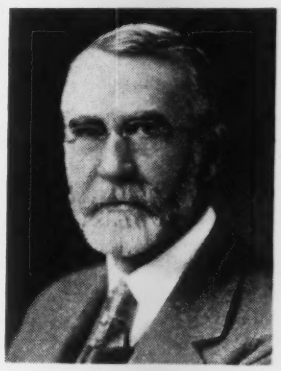
W. LE R. EMMET



ALBERT KINGSBURY

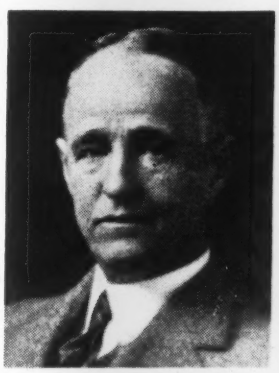
AMBROSE SWASEY

W. H. CARRIER



C. T. MAIN

EDWARD BAUSCH



E. P. BULLARD

S. J. PIGOTT

Recipients of the A.S.M.E. Medal

fornia Institute of Technology, received the 1926 A.S.M.E. Medal in recognition of his contributions to science and engineering. He has been actively engaged in research work in physics since 1895, and has contributed numerous articles to the scientific journals, chiefly in the fields of electricity, optics, and molecular physics.

WILFRED LEWIS, vice-president of the A.S.M.E. from 1915 to 1917, and member since 1884, was awarded the 1927 A.S.M.E. Medal for his contributions to the design and construction of gear teeth. The Lewis formula for the calculation of the strength of gear teeth is almost universally used today, and further research only tends to confirm the essential soundness of the conclusions of Mr. Lewis, who was chairman of the A.S.M.E. Research Committee on the Strength of Gear Teeth.

JULIAN KENNEDY, vice-president of the A.S.M.E., 1915–1917, was awarded the 1928 A.S.M.E. Medal for his services and contributions to the iron and steel industry. Mr. Kennedy was connected with practically all the iron and steel plants of any importance in this country as well as other parts of the world. Many improvements and devices relating to the manufacture of iron and steel were invented and patented by him.

WILLIAM LEROY EMMET, member A.S.M.E., received the 1929 A.S.M.E. Medal for his contributions in the development of the steam turbine, electric propulsion of ships, and other power-generating apparatus. The mercury-vapor-power process, which has been described in the publications of the Society, was invented and constructed by Mr. Emmet.

ALBERT KINGSBURY, member A.S.M.E., and an active member of several technical committees of the Society, was awarded the 1931 A.S.M.E. Medal for his research and development work in the field of lubrication.

AMBROSE SWASEY, president of the A.S.M.E. in 1904, elected to honorary membership in 1916, was the recipient of the 1933 A.S.M.E. Medal for his contributions to the advancement of the engineering profession and for his part in the development of the turret lathe and the astronomical telescope. His work lives on in the research and experiments sponsored by the Engineering Foundation which he established in 1914.

WILLIS HAVILAND CARRIER, member A.S.M.E., and a member of several technical committees of the Society, was awarded the 1934 A.S.M.E. Medal in recognition of his research and development work in air conditioning. His paper on "Rational Psychrometric Formulas: Their Relation to the Problems of Meteorology and of Air Conditioning," presented at the 1911 Annual Meeting of the Society, ranks as one of the outstanding contributions to engineering literature.

CHARLES THOMAS MAIN, fellow A.S.M.E., president of the Society in 1918, and chairman of the A.S.M.E.'s Freeman Scholarship Fund Committee, was selected as the recipient of the 1935 A.S.M.E. Medal for distinguished achievements in the textile and other industries, in engineering education, and for eminent service to the engineering profession. The Charles T. Main Award of the Society, an annual cash award of $150 to a student member, was established in 1919 from a fund created by Mr. Main.

EDWARD BAUSCH, chairman of the Bausch & Lomb Optical Company, and inventor of various scientific devices, received the 1936 A.S.M.E. Medal for meritorious mechanical developments in the field of optics. His keen mechanical mind and a desire to make America independent of European optical-instrument manufacturers led him to invent and use many automatic machines in his plant.

EDWARD PAYSON BULLARD, member A.S.M.E., was given the 1937 A.S.M.E. Medal for outstanding leadership in the development of station-type machine tools. In 1913, Mr. Bullard developed the vertical, multispindle, station type of lathe, known as the "Mult-au-matic," especially designed for high production in automobile manufacture. This was followed by the "Continumatic" in 1922.

SIR STEPHEN J. PIGOTT, director in charge of the Clydebank Works, Glasgow, Scotland, of John Brown & Co., Ltd., Great Britain, was voted the 1938 A.S.M.E. Medal for outstanding leadership in marine propulsion and construction. Born in Cornwall, N. Y., and a mechanical-engineering graduate of Columbia University, Sir Stephen went to England in 1908. As director of the Brown engine works he was responsible for the design of the machinery of the *Queen Mary*, and in his present position was in complete charge of the construction of the *Queen Elizabeth*.

Mathematical Formulas as Aids to Business Choices

(Continued from page 535)

series of years. Over a series of years these companies have had long-range growth and have also expanded and contracted with the business cycle. The receipts during a year are plotted on a straight line at 45 degrees for a scale which is the same for the perpendicular as for the horizontal. Dots show the amount of receipts in the year. The amounts are dependent on growth and the business cycle. For instance, the procession of dots of net sales of General Motors starting from low pass through the following years in order, 1917, 1916, 1921, 1918, 1932, 1922, 1919, 1920, 1924, and so on. Then on the same field and directly above or below are the total expenses of that year. Now it is interesting that the expense dots in many of the charts vary but little from a line that would intersect the gross-receipt line near the point of origin. In short, whether concerns have long-range growth or business-cycle wobbles, their expenses continue pretty much as a standard percentage of gross receipts. This seems to be in conflict with the large percentage of fixed costs assumed in the previous chapter. But most of what is fixed costs at one moment of time becomes, as Rautenstrauch points out, variable costs over the course of years. But I was surprised at how good was the fit of expenses to gross receipts over years that have had such changes in growth and price levels and business-cycle wobbles.

The last two chapters are, one on financial statements, and one called "business enterprise on a national scale"—this latter a rather interesting study of the aggregates that arise from the business system as a whole.

Now, if we sum up, we sum up with the title. The main purpose of the book is to present mathematical formulas which will be aids to business choices under diverse situations. Of course in this review it is impossible to present them in detail. Of course a person should have and use these formulas. There is only one word of caution which to most of us is unnecessary. Most people do not make the mistake of adding two and two and making five. But all of us have to make the mistake of adding x and y and calling the sum five when it should be four, because we err in our estimation of x and y. In short, if the economic assumptions are uncertain, and they usually are, the results of their manipulation must also be uncertain.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

Day by Day

INTEREST of engineers in the possible recovery of the capital-goods industries to the more normal proportions considered healthful to industrial progress had something to feed on during the last month when it was announced that the program for modifications of the tax structure had reached a stage where the Secretary of the Treasury offered suggestions of a helpful nature. But against this indication of better conditions for the carrying forward of industrial enterprises it was necessary to set the reports that little if any modification of the National Labor Relations Act would eventuate during the present session of the Congress. True, members of the NRLB admitted that certain changes in administrative procedure, such as permitting employers to petition for an election to determine the recognized bargaining unit, were under consideration, and the appointment of William M. Leiserson to the Board was thought by some, and officially by Mr. Hopkins, after his meeting with the Department of Commerce advisory board, to be a helpful step in the solution of some of the problems arising out of the disputes centered around the act. It must be remembered, however, that as long as the Board sits in the triple capacity of legislator, judge, and administrator, the vagaries of its actions, about which employers complain, will persist.

Comparative quiet on the European front, save for the disappointing turn in negotiations between the democracies and the Soviets, or perhaps the fact that international crises lose some of their disturbing effect when they are long continued, eased the tension somewhat in financial markets.

The curve of business activity continued its downward trend, begun late last fall, although, while this is being written, further decline appears to have been halted. Many commentators look for better times. Opposition to public spending, which gave promise in the early days of the Congress of becoming effective, has apparently lost its strength; the balanced national budget continues to play the role of an illusive will o' the wisp. Although defeat of the "Townsend plan" legislation in the Congress was decisive, the issue is by no means dead; it is credited already with having spurred efforts to modify Social Security legislation. All in all, the new rules of the game of conducting business enterprises are far from being settled and the technique of operation under them has not been mastered.

Settlement of the labor dispute in the bituminous-coal industry, with the exception of a few mines, resulted in a temporary victory for labor and especially the CIO, and the setting up of the "union shop," but has not been without significant reactions. A bill passed in the Pennsylvania state legislature, outlawing sit-down strikes and otherwise changing the complexion of labor disputes, indicates a feeling on the part of the public that labor leaders have already gone too far or threaten to do so. Plans are also said to be going forward in the electric light and power industry to guard against the threat of another coal shortage by equipping fuel-burning plants for the alternative use of competitive fuels, a precaution not only against labor troubles in the coal industry but also against a rise in prices. In casting about for solutions to many problems affecting the electric light and power industry, engineers will not overlook new methods of power generation which, if they assume commercial importance, will involve not only technical but social and economic problems as well.

Jurisdictional disputes and warfare between factions in the labor camp continue to bob up in the day's news, with the system of private enterprise and, temporarily at least, the public as the victims. Strikes in the shipping industry on the Atlantic coast and in automobile plants and a twenty-to-one vote of the Martin automobile union to reaffiliate with the A.F.ofL., are conspicuous examples. Settlement of problems arising out of rivalries between the craft and industrial unions appears to be as remote as ever.

Orders for two 45,000-ton battleships and 22 other war vessels, estimated to cost $350,000,000, have been placed by the Navy.

The Pan American 41-ton flying boat *Yankee Clipper*, that left Manhasset Bay, Long Island, on May 21, on the first regularly scheduled airplane flight over the Atlantic to Europe, via Horta, Lisbon, and Marseilles to England, completed its round trip on May 27, after it had been forced by adverse winds on the return journey to put in at Bermuda to refuel. The ship carried mail in both directions.

Plans to build an experimental dirigible about half the size of the *Akron*, *Macon*, and *Shenandoah* for naval experimentation were canceled by President Roosevelt on May 16. The President is reported to have said that one of the aircraft companies bidding had offered plans for a 700-ft type with the observation that smaller ships would be less safe in the air.

Main on Valuation

More than 40 years ago Charles T. Main, past-president A.S.M.E., in a paper, "The Valuation of Textile Manufacturing Property," defined one of the elements of value of a plant in terms of "its relative value to a new plant constructed on modern principles and constructed with all regard to the economical production of a finished product of the best quality of the goods manufactured." At about this time he was not permitted to testify, in a tax case, as to the value of an old mill in comparison with a new mill.

In a recent decision in the Pennsylvania Public Utility Commission case, reported in the *Engineering News-Record* of April 27, 1939, some earlier decisions of the United States Supreme Court have been clarified, and ground has been laid for simplification of valuation work in a manner which vindicates Mr. Main's statement of 1897. In commenting on the recent decision the *Engineering News-Record* says:

"That case [Smith vs. Ames] has long been held to require that in placing a value on utility property for rate-making pur-

poses the value must be based not only on what the property cost originally but on what it would cost to reproduce. But a careful reading of Supreme Court decisions of recent years will show that the court has been slowly departing from this original concept. Now, in the Pennsylvania utility-commission decision, it states more clearly than heretofore that so long as a regulatory commission considers these elements of value it need give no weight to them in its final decision. Thus these two elements are relegated to an unimportant position.

"If original cost and reproduction cost no longer have controlling weight in valuation work, the way is cleared for a simple determination of what the property of a utility is worth at the time it is being valued. This appears possible through basing value on the cost of a modern plant of equivalent capacity rather than on a detailed appraisal of the existing plant. Such a method would preserve the increments of value that should accrue to the owners of serviceable plants yet it would work toward the faster replacement of outmoded plant and equipment."

New York World's Fair

Long before the New York World's Fair opened, the daily quota of advance publicity that passed over the editor's desk, the scoffing luncheon-table comments on alleged architectural monstrosities, and perhaps resentment over the use of automobile number plates for advertising, successfully stiffened "sales resistance." Then came the previews of some of the industrial exhibits, the auspicious opening (on time), the first opportunity to wander through some of the buildings, the favorable approach to the grounds over the aesthetically satisfying and technically appealing Whitestone Bridge, and the view of the grounds by night. Since then the difficulty has been to stay away, as each trip has added fuel to the fires of enthusiasm. What had loomed as a reporter's irksome duty to write a "plug" for the scene of joint sessions of The Institution of Mechanical Engineers and The American Society of Mechanical Engineers early in September (see page 563), became a series of emotional, aesthetic, and educational experiences that put the scoffer to shame.

The architects, artists, and landscape gardeners, who created the physical setting and exhibition buildings of the Fair are being abundantly supported by Nature herself—brilliant sunshine and clear skies at times, cloud effects at others, the black vault of heaven itself against which the orb of the Perisphere, artfully lighted, appears by night to be floating as if poised for ascension at any moment—and by the skillful use of artificial illumination. The hodgepodge of unbelievable shapes and colors that greets the visitor by whatever route he elects to approach the Fair serves to heighten his amazement when he finds himself actually within the grounds. From this moment scoffing ceases and enthusiasm begins.

On seeing them, particularly by night, one finds it no longer necessary to ask what is the significance of the Trylon and Perisphere. Even from the strictly practical standpoint of a trade-mark one must admit that somebody's gray matter started to work on this "thematic center," and that the instinct for showmanship was communicated to thousands of others who developed the general scheme and the innumerable details of individual exhibits. There are many explanations of what this great show signifies, but perhaps one simple incident serves as well as any other. It concerns a little girl who saw, apparently for the first time, an escalator. "Look," she cried excitedly, "they're coming upstairs and they're not walking!" Here is the educational theme in its simple essence. But even her astonishment was anticipated, and her parents helped out of a hole, by one exhibitor who has laid the mechanism of the escalator bare behind a glass screen so that all may see how it works.

Good showmanship—lavish showmanship in many instances—has made the Fair; its diversity has provided for all levels of intelligence and appreciation. Did concentration on the word "Think" inspire the International Business Machines to adorn the walls of their exhibit with paintings from 79 different countries and justify it by reminding the observer that businessmen have always been patrons of the fine arts? Do you like the spectacular? Here it is at the Fair in profusion—the fountain in the Lagoon of Nations, for example. At nine thirty in the evening the crowd gathers around it. From the tiered balcony of the restaurant in the French building those who are rich enough to pay the price, and forehanded enough to have made advance reservations, look out from a superior height—a convex "golden horseshoe" suspended over the plebian "pit"—to watch the symphony of water jets, colored lights, fireworks, and music, integrated, controlled, and harmonized, it is said, by a "score" which the operators must follow. Turning away and looking along Constitution Mall, lined with trees to whose leaves hidden lights lend a green brilliance, one sees the Perisphere at the far end.

There is the General Motors Futurama, the highways of the future in miniature, past which in chairs on an endless belt the spectators move, and a personal microphone explains to each what he sees as he goes along. It has a capacity of 28,000 per day; but you must be there before the Fair opens unless you want to stand, as thousands do daily, for your turn.

The entrance to the Consolidated Edison exhibit pierces a long façade against which jets of water mount to the cornice and fall back into a narrow basin. Inside is the "City of Light," a huge animated model of New York by night by means of which the uses of electricity are dramatized.

Or enter the Electric Utilities display—a gas-lighted street lined with quaint shops and basement living quarters of yesterday. From its dimness you pass into the soft brilliance of the street of tomorrow, with its "sophisticated" shop windows Beyond is a circular room where lights and color effects, to the accompaniment of music and a good word for the utilities, show what can be done with illumination. But the surprise is to come out in a lounge over whose circular windows water rushes by, and to emerge into the open air through a glass penstock that pierces what appears to be the curtain of water flowing over the crest of a dam.

The Italian Building affords another waterfall effect; if you go over to the amusement area, you can see how Billy Rose makes use of water and lissome swimmers in his Aquacade; and in Chrysler's Frozen Forest, water from the atmosphere is captured in the form of a white frost on the trunks and fronds of artificial palms.

Time and space do not suffice, if words themselves would, to mention what engineers will find to interest them in the industrial displays. Television may be seen in several exhibits. Thirty-foot man-made lightning provides a thrill in Steinmetz Hall. Demonstration lectures on the things of tomorrow, research in the precommercial stage, give one something to think about while resting tired feet. The Voder, automatic key-operated talking device, answers questions put to it in a husky voice, compounded of a breathing and a vibration sound in phonetic combinations.

The half dozen trips made by this reporter provided opportunity to see a small sector of the exhibit area, but his purpose is not to report what he saw so much as it is to let others know that, whether they come to New York to participate in the A.S.M.E.–I.M.E. meeting in September, or for other reasons, they will see a grand show at the Fair. There is nothing the

country needs today quite so much as faith in itself and faith in the future. The Fair may strengthen that faith. At former fairs the automobile manufacturers showed how cars are assembled and many persons went away impressed with the apparent drudgery of working on an assembly line. Mr. Ford has glorified the machine—he has shown how it makes jobs, and he has also shown how a group of machines turns out a finished product from raw material. One cannot help thinking about it—the services of science and machinery to men as contrasted with the slavery of men to science and the machine. It comes down to a question of material advancement through expanding knowledge of the physical world and the happiness of freedom through the exercise of civil liberties. And having seen one of these demonstrated on one side of the Perisphere, one has only to step to the opposite to see the symbol of the other—the Magna Charta.

Magna Charta

It may be the world of tomorrow that has sprouted on the unpromising mud flats of the Flushing meadows, but in the vast continuum of time no tomorrow exists without its yesterdays, and no hope lies in the dawn of a new day that was not born behind the sunset of the past. New shapes, new gadgets, new machines, new tools may owe their substance to the refined oxides of iron, subtly alloyed with elements whose virtues are a more recent discovery, but the ore comes from deposits laid down before man appeared upon the earth. Through the alchemy of science man may rearrange the molecules, building up and breaking down, may shatter even the atomic nucleus itself, make energy appear where there was mass, breathe life into inert matter, and ape Nature herself in regulating the processes of growth and decay. If through knowledge he has multiplied his powers and sought freedom, it is through disciplined intelligence that he must maintain them. Thus, although twelve hundred acres of cleverly conceived and executed exhibits at the New York World's Fair remind him of these powers and what they mean to him, the spirit of freedom is enshrined with impressive dignity in one small part of the British pavilion—a parchment written in an extinct language that only scholars can read but symbolic of a living force that has survived dead yesterdays and will persist in unborn tomorrows—the Magna Charta.

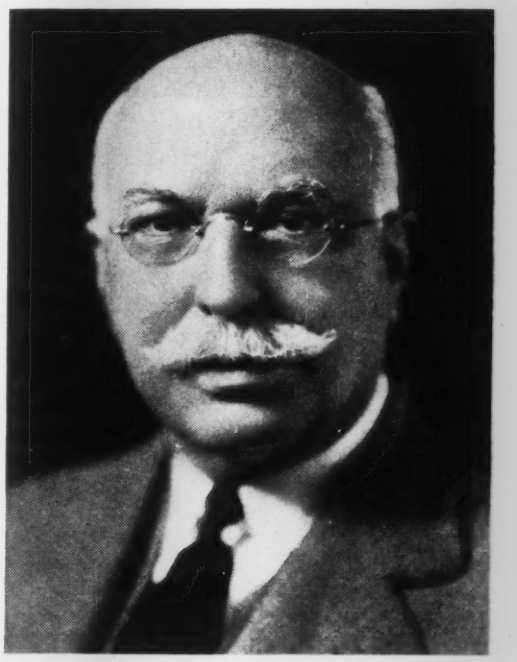
Men, women, and children approach it in a long respectful line, gaze upon it, and turn away—on their faces the impress of a variety of emotions. Among them, perhaps, is the refugee from countries where civil liberties are dead or denied; a cynic brought face to face with the essential significance of an age-long struggle; a child of liberty itself to whom political freedom has always been as natural an environment as the air he breathes; a humble member of an unprivileged race from whom constitutional guarantees are withheld; a youth for whom dead history has suddenly become alive; an intellectual zealot who cannot see that collectivist philosophies lead to the repeal of this great document; an emigrant from lands where bloodshed changed the masters of men's destinies and provided the form, but not the substance, of their liberties; a descendant of colonial pioneers whose forebears nurtured and fought for the preservation of political independence; a son of the British Commonwealth of Nations itself, proud of the heritage his ancestors bequeathed.

What divine inspiration led to the construction of this shrine, around which, in simple language, the essential guarantees of the civil liberties of a democracy are to be read? To the left a painting depicts one of the great crises of those liberties, the refusal of the peoples' parliament to grant money to the minister of Henry VIII. To the right another shows one of the great triumphs of democracy, the coronation of George VI, the sublimation through the experiences and trials of representative self-government of the hereditary tyrant into a beloved monarch, of the divine right of kings into the divine rights of the individual. Seven centuries of political evolution have merged the best of the past with the most cherished of the future. No thoughtful man can stand unbonneted here, or look upon this scene without a quickening of his pulse. The Fair holds a no more significant exhibit.

Outside, somewhat to the south, atop a tall plinth, a seventy-nine-foot steel statue of the worker extends his hand aloft to grasp a red star, and appears to be stepping forward into space. To many this will symbolize another concept of liberty and emancipation won through bloodshed and the destruction of much that might have been saved. Around the two are grouped the pavilions of the nations whose peoples look either to the parchment and glorify the individual and his liberties or to the gigantic statue of a man and glorify the state and its complete authority. Between these two concepts of society men today divide their allegiance. In this atmosphere of the world of tomorrow, as everywhere in the world of today, this seven-hundred-year-old parchment holds renewed significance as the great charter of free peoples.

William S. Barstow

On May 15 the Library Board honored one of its members, William S. Barstow, by means of a dinner, held at the Lotus Club in New York, at which the Engineering Societies Library was effectively publicized and Mr. Barstow's contributions of



WILLIAM S. BARSTOW

interest, service, and money to the library were acclaimed. About one hundred representatives and friends of the board and leaders in the field of public utilities, in which Mr. Barstow's life has been spent, gathered to do him honor. Mr. Gano Dunn presided, and with him and Mr. Barstow were seated at the head table A. R. Mumford, president of the Library Board and one of the representatives on it of The American Society of

Mechanical Engineers; Wendell Wilkie, electric-utility executive, and Harry Woodburn Chase, chancellor of New York University and president of the Lotus Club.

Seldom is it an editor's privilege to listen to a program of after-dinner speeches so well planned and carefully integrated, so interesting, so intelligently timed, and so graciously and effectively delivered as the four made by Messrs. Dunn, Mumford, Wilkie, and Barstow.

Mr. Dunn reviewed the events leading up to the founding of the Engineering Societies Library, in which he was a participant from the start, and the part played in it by the gift by Andrew Carnegie, of the Engineering Societies Building, and the Engineers' Club in New York. He paid warm tribute to the services and generosity of Mr. Barstow as a member of the Library Board, and testified to the genuine affection and admiration which his fellow engineers have for him.

On pages 533 and 534 of this issue is printed the text of Mr. Mumford's speech in which the facilities and services of the library were so well stated that publication for the benefit of engineers who support the library through their A.S.M.E. membership dues was obviously indicated.

Mr. Wilkie spoke with dramatic effect and in terms of high praise of Mr. Barstow's contributions to the electric light and power industry, and contrasted the conditions in the industry during the days of its formation and development with those existing at the present time.

Mr. Barstow's response, in friendly, modest, and reminiscent vein, was an excellent example of his complete command of a situation which was to him a surprise. When he was graduated from Columbia University, Mr. Barstow recalled, a professor of physics advised against his entering the electrical industry because it was sure to amount to nothing. However, he failed to heed this advice, got a job with Thomas A. Edison, and started on his career as an electrical engineer at a time when electrical engineering could be learned only by trial and error. His long career has covered the span of the tremendous developments in this field, in which his contributions have won for him an important place.

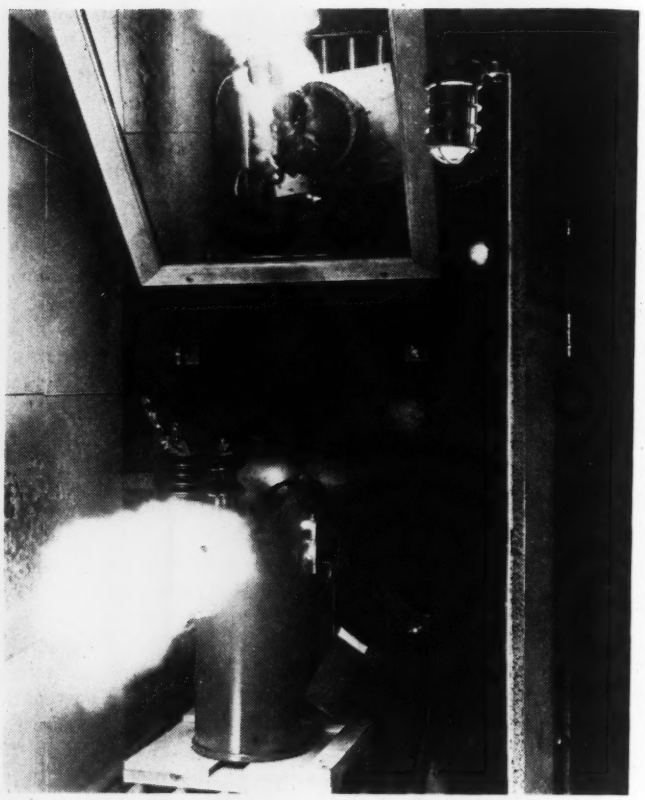
Following Mr. Barstow's response, at the request of Mr. Wilkie and the insistence of the audience, Mr. Dunn gave a graphic description of recent experiments on the isotopes of uranium in connection with the cyclotron at Columbia University which give promise of revolutionary developments in the field of atomic power.

S.A.E. World Congress

International in scope and concept was the World Automotive Engineering Congress of the Society of Automotive Engineers, which began in New York on May 22, and ended in San Francisco on June 8. The 18-day Congress had a total attendance that exceeded 4000 and included many A.S.M.E. members and several hundred delegates and speakers from 20 overseas countries.

After a six-day session in New York, the Congress left to reconvene at Indianapolis and to see the Memorial Day Automobile Race, from there went to Detroit for three days of sessions and visits to automotive manufacturing plants, was welcomed for a day in Chicago, took the Sante Fe *Super Chief* to Los Angeles, where it was entertained for a few hours, went on to Bakersfield by bus, and there entrained on the streamlined train *Golden Gate* to complete the trip to San Francisco.

Designers, production men, vehicle users, and general engineers and executives all found something of interest in the way of new technical ideas and engineering information at one or another of the 41 technical sessions which were held. Starting developments were described by American and overseas engineers in the realm of passenger cars, airplanes, tractors, motor trucks, Diesel engines, as well as other automotive fields.



MAN-MADE LIGHTNING TESTS TRANSFORMERS

(All lightning-proof distribution transformers as they come from the production line are routed through a testroom where they are subjected to direct lightning strokes produced in the new surge generator developed by the Westinghouse Electric & Manufacturing Co. Each transformer is given a stroke of lightning by applying to each terminal a surge that rises at the rate of one and a half million volts in a millionth of a second, and is followed by a tremendous flood of current of 55,000 amperes. Every three minutes a transformer comes from the production line completely surge tested. The mirror at the top permits inspectors to view the crash behind heavy soundproof walls.)

Dinners or luncheons were held in every city visited by the Congress. At the New York dinner, one of the speakers was C. F. Kettering, member A.S.M.E., who stated that engineers and management, working cooperatively, will lift us out of the doldrums and help us get ahead. He contended that, "The world of engineering today requires a broader outlook—and a better understanding between the technical side of industry and the commercial and sales divisions. We have depended too much on the law of accident for the full development of the technical branches of our industry. . . . The motor-car industry is what it is today by virtue of about three different kinds of materials—rubber, the most important; petroleum, which is next; and alloy steel, which is the third."

Officially opening the Congress in New York, W. J. Davidson, president of the S.A.E., emphasized in his address the fact that "engineers are essentially builders" and a keystone of their philosophy is never to tear anything down until they have devised something better to put in its place. The factual approach is important, he said, because "no matter what your emotions may be, the facts remain unchanged." He made a strong plea for use of a sane engineering or factual approach to all of the problems with which the world is faced today.

The Congress closed in San Francisco with a banquet, at which Fred M. Zeder, member A.S.M.E., said, "... physical laws are the same the world over, timeless and immutable, God-made and not man-made..... We engineers deal with life's fundamentals..... Our mission is to create, to build, to make the world a happier place in which to live."

Welded Pipe Joints

JOINT MEETING OF A.W.S. AND DETROIT SECTION OF THE A.S.M.E., DETROIT, MICH.

COMPARATIVELY recent increases of steam temperatures and pressures in modern power stations have imposed rigid requirements on joints in piping for this service. Carbon-molybdenum steel, because of its good physical properties and resistance to creep at high temperature, has been generally accepted as the base material for the pipe, and welding as the most satisfactory method of joining it. However, since there are differences of opinion regarding groove design, detailed welding procedure, methods of inspection, and heat-treatment subsequent to welding of joints, R. W. Clark, engineer in the works laboratory, General Electric Company, Schenectady, N. Y., carried out two sets of tests to clear up these various points. The tests and results were described by Mr. Clark in a paper presented at a joint session of the American Welding Society and the Detroit Section of The American Society of Mechanical Engineers in Detroit, Mich., Oct. 18, 1938, and published in full in the January, 1939, issue of *The Welding Journal*.

The first series of tests was made to determine the effect of groove design by comparing four representative types, both in horizontal and vertical positions (see Fig. 1), the necessity for the general chipping of each bead, and the value of a recording voltmeter as a means of checking soundness of welded joints. The second series was made to determine the residual stresses in pipe joints welded at three different temperatures when tested in the "as-welded," "furnace stress-relieved," and "local stress-relieved" conditions.

Examination of radiographs, macrosections, physical test results, and observations during welding showed that all four types of groove designs produced sound welded joints. Results of the first series of tests also indicated that, with the welding procedure and the groove designs used, general chipping of each bead and of craters was not necessary. These tests proved, more than anything else, that in order to insure satisfactory welded joints in any structure, it is necessary to comply with the following procedure:

1 Establish and qualify the welding procedure
2 Qualify the operator under the procedure
3 Properly supervise and inspect visually during welding.

In comparing test results with the recording-voltmeter records, no defects were found corresponding to the irregularities in the arc-voltage records.

The results of the second series of tests is shown graphically in Fig. 2, where it is seen that the greatest deflection occurs in the pipe welded at room temperature and tested in the "as-welded" condition, and decreases as the preheating temperature is increased. The effect of furnace stress relieving was the greatest on specimens welded at room temperature and the least on specimens welded at 500 F, as indicated by the curves shown in solid lines.

Curves for specimens tested in the "as-welded" condition and in the "furnace stress-relieved" condition are of the same general shape. The curves for specimens welded at room temperature and tested in the "as-welded" condition show the

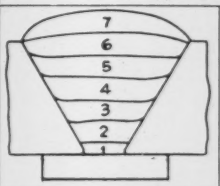
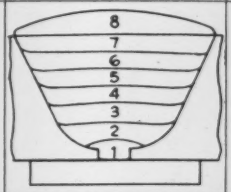
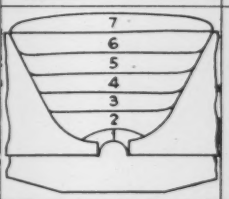
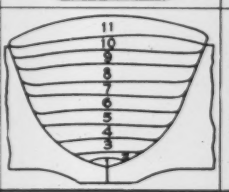
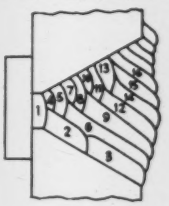
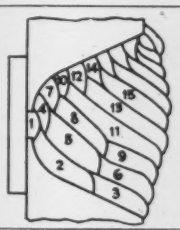
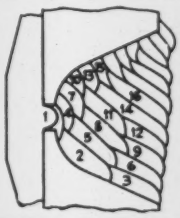
Electrode Manipulation	Type, Position, Thickness, and Number of Beads	
A whipping action was used in depositing the 1st bead. On all other beads a pool of molten metal was carried and a weaving motion was used.		1. All weave beads 2. Avg. thickness 5/32" - 3. Total No. beads 7
Same as S51-C-12 Joint Design No. 1		1. All weave beads 2. Avg. thickness 1/8" - 3. Total No. beads 8
Same as S51-C-12 Joint Design No. 1		1. All weave beads 2. Avg. thickness 5/32" - 3. Total No. beads 7
Same as S51-C-12 except that whipping was necessary on the first three beads		1. All weave beads 2. Avg. thickness 1/8" 3. Total No. beads 11
A pool of molten metal was carried fairly continuously in depositing the string beads in the corners. no weaving was possible. in depositing the wider weave beads. A weaving motion was used.		1. Combination of weave and "string beads. 2. Thickness Weave beads 5/32" - String beads 5/32" 3. Total No. beads 20
Same as S51-C-14 Joint Design No. 1		1. Combination of weave and "string beads 2. Thickness Weave beads 5/32" - String beads 5/32" 3. Total No. beads 24
Same as S51-C-14 Joint Design No. 1		1. Combination of weave and "string" beads 2. Thickness Weave beads 5/32" - String beads 5/32" 3. Total No. beads 25
Same as S51-C-14 Joint Design No. 1		1. Combination of weave and "string" beads 2. Thickness Weave beads 5/32" - String beads 5/32" 3. Total No. beads 28

FIG. 1 WELDING CARBON-MOLYBDENUM PIPING

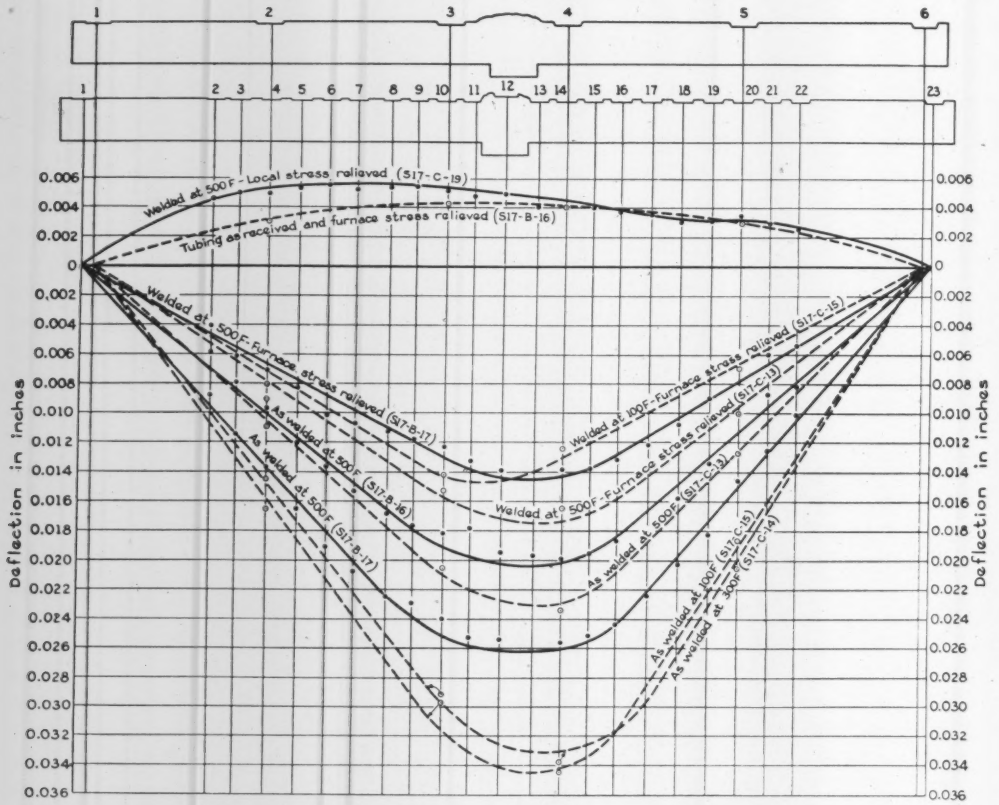

Welded at 500 F - Local stress relieved (S17-C-19)
Tubing as received and furnace stress relieved (S17-B-16)
Welded at 500 F - Furnace stress relieved (S17-B-17)
Welded at 100 F - Furnace stress relieved (S17-C-15)
Welded at 500 F - Furnace stress relieved (S17-C-13)
As welded at 500 F (S17-B-16)
As welded at 500 F (S17-B-17)
As welded at 100 F (S17-C-13)
As welded at 500 F (S17-C-14)
Deflection in inches
Deflection in inches

FIG. 2 CHART SHOWING DEFLECTION CURVES OF STRIPS CUT FROM WELDED PIPES

greatest deflection and the sharpest bend. While the three curves for specimens welded at 500 F and tested in the "as-welded" condition show some variation in the maximum deflection, they have about the same shape and location of bend. Curves for specimens welded at both 100 F and 500 F and furnace stress-relief annealed are nearly identical and show less deflection and bend than similar specimens tested in the "as-welded" condition.

The curve for specimens from the welded pipe, after local stress relieving, indicates that stress in the area around the weld has been apparently removed. However, the shape of the curve indicates that the specimens were not long enough (15 in. for dotted lines and 30 in. for solid lines) to give a true picture of the stress conditions resulting from the temperature gradients due to local stress-relief annealing.

All-Welded Model Girder Tests

WELDING RESEARCH COMMITTEE OF THE ENGINEERING FOUNDATION

MAINTENANCE of geometrical similarity between steel models and full-size engineering structures is greatly facilitated by means of fusion (electric-arc) welding, provided that the difficult operation of welding thin-gage metal has first been successfully mastered, according to a paper by H. E. Lance Martin, British engineer, which is reprinted in the February, 1939, report of the Welding Research Committee of The Engineering Foundation. Models made by this process are useful because not only may the welding procedures and the resulting residual strains and stresses be determined but also the behavior of the finished product may be found under the predetermined loads together with the fatigue limit if required. Knowledge thus obtained from steel models, says Mr. Martin, may be applied directly to the design and fabrication of corresponding full-sized all-welded structures. This is important because of the increased demand for all-welded structures in prefabricated houses, low-cost-housing projects, shipbuilding, and other forms of construction.

The model used in the tests weighed 58 lb as compared to its full-size prototype weighing more than 7000 lb. It was fashioned of 14-gage steel and was 98 in. long with a depth of 9¼ in. The load was applied to the model girder in 560-lb steps to 5600 lb where it was allowed to remain on the girder for several minutes. The deflection remained at the constant figure of 0.165 in. throughout this period. The load was then raised to 7300 lb; the deflection remaining steady at 0.22 in. On reducing the load to 2240 lb it was found that a permanent deflection of 0.04 in. was registered. Finally, the load was increased again until the girder showed signs of yielding, the maximum value attained being 8400 lb with a deflection of 0.26 in. This load was released quickly so as to prevent unnecessary damage to the girder. The results of the remeasurements after a lapse of two months showed that the release from external tension reduced the residual strains and that the release from external compression increased the residual strains.

In the test to destruction the girder was placed in the testing machine in the reverse way to that which it was in the first test. On reaching the working load of 5600 lb for the second time, the deflection registered was 0.135 in. Creeping commenced at 11,200 lb but apparently ceased after a short interval. At 12,320 lb failure took place by the serious buckling of the web and top flange at the end of the second cover plate. It is difficult to say whether the final cause of failure was due to the buckling of the web or that of the compression flange. The results of the mechanical tests definitely proved that welded scale models can be successfully constructed to fulfill the conditions applying to full-size service structures.

Owing to the enormous field of inquiry opened by the successful results of the work, only a few of the more outstanding conclusions are mentioned. They are:

1 That practical scale models, using the principle of geometrical, or alternatively that of dynamic, similarity can be successfully fabricated by the electric-arc process of welding.

2 That the freedom from visible distortion of the fabricated structure proves the soundness of the welding procedure adopted and that the results of the mechanical tests demonstrate that the strength and ductility of the welds were entirely satisfactory.

3 That the new technique of measurement has proved applicable to the accurate determination of residual strains and stresses in all-welded mild-steel structures.

4 That the technique has indicated some of the effects that the release of external loading has upon the residual strains and stresses in all-welded mild-steel structures.

5 That correct "welding procedures" applicable to fusion welding in naval architecture and structural and mechanical engineering may be quickly and at small cost studied and determined by the methods briefly indicated.

6 That the results of this preliminary work have clearly demonstrated that both economical and safe service structures will follow from the specialized design, fabrication, and testing of the corresponding all-welded scale models.

A New Electrical Machine

THE PHYSICAL SOCIETY (GREAT BRITAIN)

A NOVEL type of electrical machine, that does not depend on friction or induction but on the electrification created when an insulating material in the form of powdered silica falls through a perforated zinc plate, was described by Sir Ambrose Fleming, eminent 90-year-old English physicist, before The Physical Society, in London, England, on April 28, 1939. The complete paper, from which the following abstract is taken, is published in *The Proceedings of the Physical Society*, May 1, 1939.

According to Sir Ambrose, his machine is based on the fact that when certain insulating materials, the best of which appears to be pure silica (SiO_2), in a certain state of fineness of powder, are allowed to fall down a tube and strike a metal plate perforated with small holes or a metal-wire gauze of zinc, copper, nickel, or iron, the metal plate becomes electrified positively and the insulating powder negatively. There are, however, certain conditions to be satisfied. The powder, which may be of silica, sulphur, silver, river sand, or certain other materials, must have grains of nearly equal size, about 0.01 in. in diameter, and must be dried so as to be free from all moisture. Furthermore, the screen or perforated plate should have 70 apertures per sq in. for zinc and 600 apertures per sq in. for copper, which will allow the particles to fall through and not accumulate on the screen. However, there are wide limits permissible in the ratio of area of hole or mesh aperture to size of grain.

The machine, shown in Fig. 3, consists of a cylinder of ebonite which has hollow axes fixed to its flat ends. These are supported in wood bearings so that the cylinder can be rotated about the hollow axes. Metal tubes are fixed in this drum like spokes of a wheel, and each tube carries at its outer end a metal canister or hopper in which powdered silica can be contained. As this drum and its spokes revolve, the powder will fall down out of the canisters at the high position and be collected again in those in the lowest position.

Across the inside of the ebonite drum is fixed a rectangular partition of perforated zinc. This is carried on fixed metal axes which pass loosely through the hollow ebonite axes of the drum, and therefore the partition does not rotate with the drum. As the drum is rotated the silica powder is continually being dropped on the upper side of the zinc partition and passing through it is collected again by the radial tubes in hour-

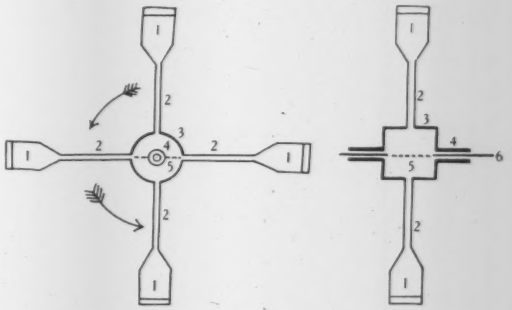


FIG. 3 FRONT AND SIDE VIEWS OF A NEW ELECTRICAL MACHINE

[(1) Metal hoppers for delivering or receiving the powdered silica or other powder, (2) metal fall tubes, (3) ebonite cylinder, (4) hollow ebonite axes on which the cylinder revolves, (5) a fixed diaphragm of perforated zinc, and (6) metal-wire connection from diaphragm to the electric storage condenser.]

glass fashion. The charges of positive electricity given to the zinc partition are led away by the metal axes to an electric condenser. By separating the plates of this condenser at intervals, it is possible to obtain an electric charge at very high potentials. Sir Ambrose feels that much additional research is required to obtain an understanding of the electric phenomena involved.

Gas Temperature Measurement

THE INSTITUTE OF FUEL

A SYMPOSIUM on gas temperature measurement was held in London, England, Dec. 2, 1938, by The Institute of Fuel. The 16 papers presented at this symposium, together with discussions, are published in the March, 1939, issue of the *Journal of the Institute of Fuel*. Reviewing the published papers as a whole it is possible to draw certain conclusions with regard to the present state of gas pyrometry, chief of which is that all those taking part in the symposium show close agreement in their views on all the essential matters raised in an international discussion of this character.

The authors and discussers are concerned with one or another aspect of the contrast between the accuracy with which the points on the international temperature scale can be measured and the temperature of a gas related to these, providing there is thermal equilibrium, and with the uncertainties and difficulties introduced as soon as thermal equilibrium disappears. The two principal cases where thermal equilibrium is absent are, first, in the flame itself, and, second, when the hot gas is contained within cool walls. The first case is discussed in the paper presented by Prof. G. Ribaud, member of the Faculté des Sciences de Paris, who claims that temperature measurements are meaningless in a gas where intense irreversible chemical reactions are in progress. However, most of the discussions center around the second case where a gas is exchanging heat with its surroundings. But no clear guidance as to the most appropriate thermometric methods for all possible cases is given. On the contrary, many of the authors emphasize the importance of careful selection of thermometric apparatus to be used in any case.

The principal value of the 16 papers and attendant discussions is undoubtedly in the detailed discussion. All papers and discussions merit close study by anyone who is concerned in the practical aspects of this problem. Among the new ideas advanced which may prove fruitful in the future is the one put forward by J. G. Bennett and M. Pirani, who suggest the use of "pseudo temperatures" in systems not in thermal equilibrium.

Prof. A. Schulze, Physikalisch-Technische Reichsanstalt, Berlin, reviews the progress made in recent years in the use of thermocouples for temperature measurement, especially with noble-metal types which are made of two or more of the following precious metals, platinum, rhodium, iridium, ruthenium, palladium, and gold. These thermocouples may be used at high temperatures ranging from 1000 to 3000 F. Professor Ribaud, in discussing some of the papers, suggests an orifice method for determining temperature in terms of density. Another of the discussers, Dr. Morris W. Travers, calls attention to the pulsation of flames as a further disturbing element in gas temperature measurement.

The "Plastic" Airplane

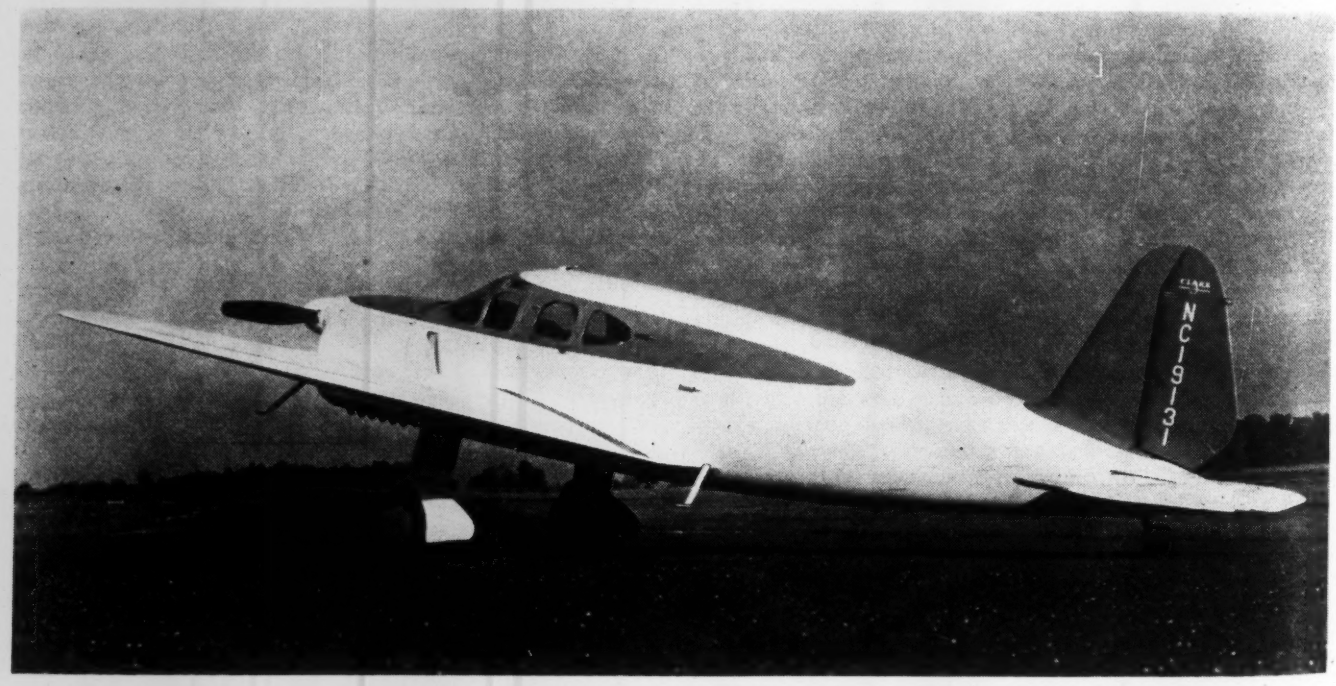
S.A.E. WORLD AUTOMOTIVE ENGINEERING CONGRESS

MANY STORIES have appeared during the last year and a half in the daily press about a "plastic" airplane which has been undergoing service tests. But, according to V. E. Clark, president, Clark Aircraft Corporation, in a paper presented before the S.A.E. World Automotive Engineering Congress at the New York session, May 26, 1939, the fuselage is made of "Duramold," which is not a plastic in the true sense of the word. But details regarding the basic materials, process, and apparatus were not divulged by Colonel Clark.

However, he did say that certain inexpensive species and grades of healthy straight-grained wood, because of the fine natural cellular structure, have a very favorable relationship between tensile strength and specific gravity, excellent elastic properties which permit the material to be stressed almost to the point of rupture without permanent deformation, and low density. It is comparatively easy to insure uniformity by proper inspection and lamination of the wood in thin veneer form. Then, another material in which bakelite plays a large part is applied through delicate combinations of heat, pressure, time, and thermosetting resins. There is practically no change in moisture content throughout the molding operation. A complete half shell of lengths up to 40 ft and areas up to 500 sq ft may be formed, with smooth, permanent, simple, or compound curvature, in the same quick and simple operation as that which permanently unites the various basic elements of the shell. In its final form, Duramold is sufficiently nonhygroscopic and free from attack from fungi or molds and other kinds of deterioration to answer all practical requirements of airplane operation.

In resistance to fatigue for equal weight per unit area, based on allowable stress, Duramold is about 50 per cent better than 17ST duralumin, Colonel Clark claims. Having no hysteresis within the proportional limit which, in tension, is practically the same as the ultimate strength, there is no creep. It is noted that the specific tenacity of one grade of Duramold is about the same as that of 202,000-lb steel. However, this is not of great practical importance inasmuch as the density of the material (in an unreinforced shell) and the elastic modulus are the only characteristics which enter into the structural-design calculations of almost all the critical parts of wing and fuselage shells. The material will not support combustion and is not subject to corrosion. The energy-absorbing characteristics are excellent and the damping of vibration is about five times greater than that of metal.

The finished external surfaces are smooth, and calculations, based on wind-tunnel tests at a fairly high Reynolds number, indicate that, for a high-speed airplane having fuselage, wings, and fixed tail units of Duramold, in the order of 25 per cent less power will be required at a given high speed than for an all-metal airplane with projecting rivet heads, lap joints, and the inevitable waves and wrinkles which are present in flight and after service.



CLARK AIRPLANE WITH A DURAMOLD FUSELAGE

LETTERS AND COMMENT

Brief Articles of Current Interest, Discussion of Papers in Previous Issues

Influence of Steam-Flow Metering Equipment on Piping Design

To the Editor:

For several years those familiar with fluid metering have been calling attention to the necessity of providing suitable installation conditions, particularly for rate-of-flow meters of the differential-head type. In the fuel-gas industry, where such meters are used extensively, satisfactory installation conditions are now provided almost always. It is gratifying to see from Mr. Van Duzer's paper,[1] that the designers of steam-plant piping are beginning to give the necessary consideration to provide satisfactory meter installations. If this had been done more extensively in the past it is probable there would have been fewer complaints of inaccurate meters.

Mr. Van Duzer asks why it is not possible to publish tables or curves giving the approximate possible errors that might result if all of the various installation requirements are not fully complied with. I believe there are two primary reasons why this has not been done. In the first place, when making tests to determine what constitutes satisfactory installation conditions it was not possible to cover an infinite variety of conditions. It was necessary to generalize these conditions by a few combinations which it was hoped would be fairly representative. Therefore, only by the use of some arbitrary basis of extrapolation could the errors observed with these few combinations be applied to others.

The other reason is that the publication of such possible errors might lead to unnecessary disputes over measurement results. For example, a person interested in the purchase or sale of a fluid through a head meter, but having no knowledge of fluid metering, might insist on having a correction based on these approximate error values applied to the meter indications. Now, even if this meter installation appeared exactly similar to one used in the tests it is not at all certain that the error would be the same. In addition to this, it is probable that the installation would not exactly correspond to the conditions used in the tests. In such a case the attempt to apply a correction factor might make the meter indications more inaccurate rather than less.

It seems appropriate to mention here that a recent review of some of the results of tests on the effects of installation conditions has indicated that for some conditions it may be possible to lessen the lengths of straight pipe required as at present given in the report of the Fluid Meters Committee. To verify this, the Committee has approved the carrying on of a limited number of tests. These tests will probably be made in Washington during the coming year.

Howard S. Bean.[2]

To the Editor:

There are a number of piping problems connected with the installation of flowmeters in industrial plants, which probably do not occur in the modern central station.

Inadequate drainage, particularly in horizontal lines, is believed to be the cause of unsuspected error in the measurements, and occasional damage to the orifice.

The author has already mentioned the importance of uniform velocity distribution, smoothness of the filler pipe, and concentricity of the orifice with respect to the pipe. All of these fundamentals are violated if condensate is allowed to back up ahead of the orifice.

It is not an uncommon experience to find orifice plates so badly distorted by water hammer as to be unfit for use, and damage from water erosion is a frequent occurrence.

Where a long run of horizontal pipe is to precede the orifice location, a separator and trap should be considered as essential parts of the flowmeter installation.

Another item, which may even be included with the author's list of considerations for the designer in the central station, is that of maintenance. In many industrial plants where a large quantity of process steam is generated, the boiler feed is likely to contain a high percentage of chemically treated make-up which tends to foul the steam lines. For such conditions, frequent cleaning of the orifice pipe is required to maintain acceptable accuracy of the meters.

The provision of facilities for inspection and maintenance of the orifice assembly is truly a problem for the designer rather than the general-repair foreman. Such features as shutoff valves, by-pass lines, platforms for access to the orifice, properly placed hangers to support the line when the filler pipe is removed, and jacks for spreading the flanges, are important details in well-designed meter installations.

The layout of a flowmeter to serve a reciprocating steam engine presents a difficult piping problem which should not be attempted without consultation with the meter manufacturer. Due to the pulsating flow, harmonic pressure waves of several pounds amplitude are likely to occur at the orifice, with a resulting error so great as to make the meter useless.

For a steam line serving a single engine, which runs at approximately constant speed, the pressure waves can be eliminated by providing a fixed throttling device between the measuring orifice and the engine. The amount of throttling necessary can be materially reduced by adding a receiver or separator at the engine.

As there are at the present time, practically no available data for calculating the required combination of resistance and capacity, the designer must rely upon experimentation. The presence of harmful pressure waves is easily detected by attaching a steam-engine indicator to the downstream pressure tap of the orifice.

Rawleigh M. Johnson.[3]

To the Editor:

Mr. Van Duzer brings out several points which are too frequently either entirely ignored or are deferred for consideration until the piping-system design is well along, thereby resulting in the

[1] "Influence of Steam-Flow Metering Equipment on Piping Design," by R. M. Van Duzer, Jr., Mechanical Engineering, November, 1938, pp. 834–836.

[2] Chief, Gas Measuring Instruments Section, National Bureau of Standards, Washington, D. C. Mem. A.S.M.E.

[3] Ingersoll-Rand Company, Phillipsburg, N. J.

adoption of a layout which may not contain the best metering conditions consistent with economical design.

The question of the pipe size to be used in the metering section is one that requires careful study and an accurate knowledge of the installed costs of various sizes of pipe. These costs will be dependent on (1) the design pressure of the system, (2) the pipe sizes involved in the problem, (3) the number of joints in the metering section, and (4) the type of joint, i.e., welded or flanged, and the design pressure of the flanged joints.

Based solely on the economics of the problem, without consideration of the meter accuracy, the amount of money available for the installation of larger pipe is small, except in the case of meters of the highest and the next lower differential. In the case of one well-known meter manufacturer whose equipment falls in the higher cost brackets, the price differentials between the costs of meters only, f.o.b. factory, for various differentials are shown in Table 1

TABLE 1 PRICE DIFFERENTIALS OF METERS

	—Design pressure, lb—		
Between heads of	1500	900	800
53 and 120 in.....	$ 50	$ 50	$25
120 and 212 in.....	165	165	
212 and 331 in.....	710	685	

Furthermore, generally speaking, the higher-head meter will give more accurate metering results, as fixed errors in obtaining an indication of the true differential will represent a larger percentage of the lower differential, and this will obtain until velocity in the primary element introduces errors in excess of the fixed errors.

The problem of obtaining good conditions ahead of the primary device is of extreme importance. In at least two recent installations, an 8-ft section of piping was bored to as nearly true circular cross section as possible and the diameters at each end of this section were obtained before the primary device was fabricated. In both of these installations the primary device was fastened in the pipe at the same time that a butt joint in the piping system was made, so that the supporting ring of the primary device formed the backing strip for the welded joint.

D. G. REID.[4]

TO THE EDITOR:

Mr. Van Duzer's paper covers, in an interesting manner, an important subject from the standpoint of design of steam-power-plant piping.

[4] Mechanical Engineer, Sargent & Lundy, Inc., Chicago, Ill.

It is frequently difficult to obtain a desirable length of straight pipe in which to locate the flowmetering equipment because of the crowded condition of the units in steam power plants, but in many installations the proper location of the primary portion of the metering equipment has been ignored. In some cases, one in particular, the meter company's specifications for the primary-device locations were not followed and the metering equipment was later criticized because of inaccuracies. In another plant, three installations have been made within the last five years, all of which were approved by the meter manufacturer, that are located either in piping bends or are too close to fittings and other obstructions. The best of these has its concentric orifice located in a piece of 10-in. extra-heavy pipe (all welded joints) 30 diameters in length with a length of 23 diameters preceding the orifice and a length of 7 diameters following the orifice. The straight pipe in this case is preceded by a gate valve and a separator (for use when necessary to turn wet steam into the system). In this initial straight section, however, there are two 3-in-diam openings for future use. One of these openings leads off from the side on which the manometer connections are made, while the one nearest the orifice leads off from the opposite side. These three meters show results that are within from 1 to 2 per cent of being correct at the lower rates of flow, but begin to diverge to a greater extent with increased flow until at around 50 per cent of the meter capacity the results are from 12 to 15 per cent high.

As an example of the effect of fittings on the velocity distribution in a circular pipe, a 27-in. duct with air entering at right angles 9 diameters ahead of the metering point shows a symmetrical velocity pattern up to maximum velocities of 1000 fpm, but beyond this range and up to maximum velocities of 2000 fpm the maximum velocity is close to one side and above the horizontal. This same distribution is repeated year after year in this installation. In such a setup, therefore, accurate results with a nozzle or orifice would be expected at the lower rates of flow but erratic results would be expected for the higher velocities because the average static pressure of the section would not necessarily be shown by the instrument. The tendency, apparently, is for a component of the velocity to be in the direction of the tap opening or away from it producing either an impact or aspirating effect.

The variation in turbulence and in the velocity pattern with different rates of flow, which would cause varying coefficients of discharge, is the principal objection to fittings near metering points if means are available for checking the device. In going from one setup to another, however, the lack of duplication of results under seemingly similar arrangement is the principal objection for general use as the actual coefficient cannot be accurately predicted.

BYRON E. SHORT.[5]

TO THE EDITOR:

The effect of pipe diameter in the determination of orifice coefficients becomes of gradually increasing importance as the ratio of orifice to pipe diameter increases. High values of this ratio should be avoided because corrosion, sediment accumulations, and warping change the characteristics of the pipe after installation. A higher arbitrary limit of the ratio should be placed on carefully installed orifice plates in selected pipes when the pipe is of larger diameter, because accumulations of corrosion and sediment do not increase in geometric proportion, and also because the width of the flat portion of the pressure curve downstream from the orifice is greater.

There are other reasons why high d/D ratios are undesirable. Eccentricity and axial variations make it impossible to determine an exact pipe diameter, viscosity has a greater effect on the coefficient, and exact location of pressure taps becomes increasingly important.

Satisfactory flow measurements cannot always be made in a line of inadequate size, because frequently increase in differential range may involve undesirable ratios of differential to static pressure.

Manufacturers of refinery apparatus now quite generally calculate line sizes to give reasonable orifice-to-pipe ratios. No piping-design job is complete unless consideration is given to the metering equipment which forms a part of it.

The Fluid Meters Research Committee has available quantitative data on the errors produced by disturbances upstream from orifices. It is difficult to interpret these data in the form of definite recommendations, because the allowable measurement tolerance will vary with the company or application requirements. At the time the proofs on the first edition of "Fluid Meters, Their Theory and Application" were being checked, in January, 1936, the writer strongly advocated showing the quantitative results of disturbance tests made by the joint A.G.A. and A.S.M.E. Committee in the

[5] Associate Professor of Mechanical Engineering, University of Texas, Austin, Texas. Mem. A.S.M.E.

form of curves. The importance and value of this information to the public would appear to justify issuing a supplementary publication. Such information should be extremely valuable, not so much to the piping designer in effecting economies in piping costs, but more to the measurement engineer in permitting him to use his own judgment with regard to the desirability of straightening vanes.

Many engineers might be influenced to use vanes where they do not now use them if they realized that a disturbance as far as 55 pipe diameters from the orifice might produce more than a 3 per cent error, as shown in the curves presented by Mr. Bean.[6] This error, like all errors due to swirl-producing disturbances, was eliminated by using straightening vanes.

Various publications showing quantitative results of disturbance tests are available. Mr. Bean plotted one section of test data shown in the previously mentioned publication; the writer plotted another section, and composite curves have been published.[7] The Fluid Meters Committee has the data and facilities for publishing more complete information.

Tests were performed on a limited number of swirl-producing combinations, and it is possible that combinations producing much more serious disturbances than those used in the tests are in common use in power plants. Most measurement engineers, with this in mind, and with the plotted data before them would run no risk of sacrificing the accuracy of their metering equipment inasmuch as absolute protection only involves a nominal additional investment in a straightening vane.

It is probable that publication of the quantitative data on disturbance tests might lead to valuable conclusions in other engineering branches. If two elbows in different planes ahead of an orifice plate result in a pressure drop through the orifice plate approximately 20 per cent different from that which would occur if the two elbows were in the same plane, it is likely that the arrangement of fittings in a system of piping may alter the pressure drop of other fittings in their vicinity.

Straightening vanes are now being widely used to reduce the noise due to disturbance produced by regulating valves and other disturbing fittings. Since there appeared to be a relation between the amount of noise and the error in the meter readings, the curves which the writer proposes that the Fluid Meters Committee publish would be of assistance in determining where vanes could be used to reduce noise.

The writer thoroughly agrees with the author's suggestion regarding choosing pipe for meter runs. This is now general practice in the gas industry where extreme accuracy is necessary. Steel tubing in standard pipe sizes manufactured to close tolerances is now available and should receive consideration for use in meter runs.

L. K. SPINK.[8]

TO THE EDITOR:

In calling attention to the necessity of providing adequate lengths of straight piping both preceding and following proposed primary-element locations, and to the necessity of choosing that size of piping which will permit of satisfactory flowmetering, Mr. Van Duzer has performed a service to the mutual advantage of both the user and the meter manufacturer. There is no question but that there is a need for closer cooperation between the piping designer and the meter manufacturer. Too many times has it been necessary to make a compromise installation, which is not entirely satisfactory to either the user or to the meter manufacturer because inadequate provisions were made in the beginning in the layout of the piping system. The meter manufacturer is always happy to advise his customers as to the best possible piping layout commensurate with the required accuracy of flow measurement, but once the piping system has been laid out and fabrication started, it is ofttimes impossible or at least difficult to make the required changes.

To Fig. 1 and the description of piping requirements, as given in Mr. Van Duzer's paper, the writer would make several additions and comments:

1 A long-radius bend of at least five- to six-diameter radius can be considered as developed straight pipe and can immediately precede the primary-element location, provided this long-radius bend is, in turn, preceded by a run of straight pipe sufficiently long to eliminate any disturbances which may have been created by bends or other directional-change fittings preceding the straight pipe. This is shown as Fig. 1 (*a*) herewith. One cannot, however, consider two or more long-radius bends in any piping system as being equivalent to developed straight pipe, nor can one long-radius bend be so considered if fittings or an inadequate length of straight pipe precede the bend.

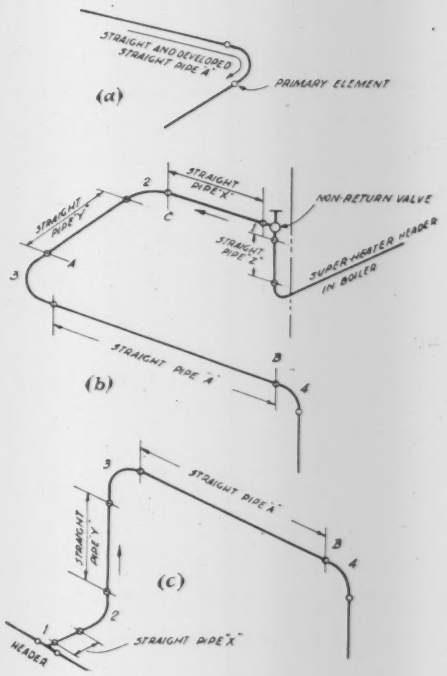


FIG. 1 TYPICAL STUDIES OF PIPING LAYOUTS

The length of straight pipe preceding such a bend as required for any installation would be determined from the upper right-hand graph of the author's Fig. 1.

2 In any system of piping involving two or more bends or equivalent of bends, as outlined in the following paragraphs 3 and 4, the entire piping system should be studied and not merely that portion of the piping immediately adjacent to the proposed location of the primary element. In other words, one cannot start in the middle of a piping system, assuming that at that point there are no swirls or disturbances present, but must trace the origin of the flow to its source. For example, referring to Fig. 1 (*b*) and (*c*), it is not permissible to consider only the length of straight pipe *A*, which would immediately precede the primary-element location at point *B*, without taking into account the possibility of disturbed flow from bends 1, 2, and 3 entering straight pipe *A*.

3 Branch take-offs through tees, Y-fittings, angles, stops, or nonreturn valves must be considered as short radius bends. For example, the flow through the nonreturn valve as shown in Fig. 1 (*b*), as well as the flow from the header into the branch line at point 1 as shown in (*c*) of the same drawing, must each be considered as flow through a 90-deg bend.

4 In any system of piping having several bends in the same or different planes, which are separated by short lengths of straight pipe, that length of

[6] "Developments in the Application of Orifice Meters to the Measurement of Fluids," by H. S. Bean, Pennsylvania State College Bulletin No. 20.

[7] Handbook, "Principles and Practice of Flow Meter Engineering," by L. K. Spink, published by The Foxboro Co., Foxboro, Mass., November, 1937, p. 150.

[8] The Foxboro Company, Foxboro, Mass.

straight pipe following such system of bends which immediately precedes a primary element, must be equal to or greater than length M as specified in either of the two lower views of Mr. Van Duzer's Fig. 1, as the case dictates. For example, referring again to Fig. 1 (*b*) and (*c*), and assuming we have a 70 per cent diameter-ratio primary element to be installed at point B, then the length of straight pipe A in (*b*) should be 18 diameters, and the length of straight pipe A in (*c*) should be 27 diameters to provide a satisfactory installation at point B. On the other hand, if the length of straight pipe Y is sufficient to eliminate any disturbances set up by the bends preceding it, only one bend need be considered and the length of straight pipe A would be 16 diameters, in both cases, as determined from the upper right-hand graph of the author's Fig. 1. In this case, bend 3 can be considered as developed straight pipe.

Many more examples could well be given, illustrating the points described, but we believe these are sufficient to form a basic understanding of the principles involved. Research studies on correct piping layouts are being developed continuously. As such additional knowledge becomes available it is incorporated in the recommendations of the meter manufacturer to his prospects. Eventually it is hoped a large number of data based on such research will be available to, and thoroughly understood by, all users.

While Mr. Van Duzer recommends a maximum diameter ratio for any primary element of 70 per cent, we have many times found it necessary to use primary elements with higher diameter ratios and have done so quite successfully. Obviously, with higher diameter ratios, greater lengths of straight pipe must be used, preceding and following the primary element, and in such cases it is even more necessary to consult the flowmeter manufacturer before definitely deciding upon a location. However, the use of the lower diameter ratio is always desirable wherever possible.

R. E. SPRENKLE.[9]

TO THE EDITOR:

While Mr. Van Duzer's paper does not contain any material which is new to the flowmeter engineer, the flowmeter industry should be grateful to him for the frankness with which he has discussed a condition that has existed for too long a time. The lack of recognition of the meter-installation problem by the piping designer has made it difficult for the flowmeter manufacturer to correct the situation. The engineering departments of most meter manufacturers are loathe to recommend installations which they recognize to be faulty. But they can do little about it, if the piping designer fails to give consideration to the essentials which must be met to obtain accurate metering. It is not unusual for a flowmeter engineer to recommend to his sales department that the customer make changes in the piping, but the sales department usually wins out with the familiar argument, "If we do not sell this job without recommending piping changes, so-and-so company will." Mr. Van Duzer's plea for greater cooperation between the piping designer and the meter manufacturer should, therefore, be welcome to flowmeter engineers.

Since flowmeters are purchased to measure, they might just as well be installed so that their inherent accuracies are obtained. The following factors contribute to the over-all inaccuracy of head-meter readings:

1 Faulty installation, or design, of the primary element.

2 Incorrect measurement of the differential pressure.

3 Incorrect transmission of the differential-pressure measurement to the meter body.

4 Inaccuracy in secondary element.

Since only the first three items are related to the proper installation of the meter, they alone will be discussed, and for brevity the remarks will be confined to the orifice meter.

The piping designer must appreciate the fact that the accuracy of the meter is based upon the closeness with which the actual coefficient of discharge of the installed primary element approaches that assumed in designing the meter. Consequently, its installation should be made comparable to that used in the experiments from which the discharge coeffi-

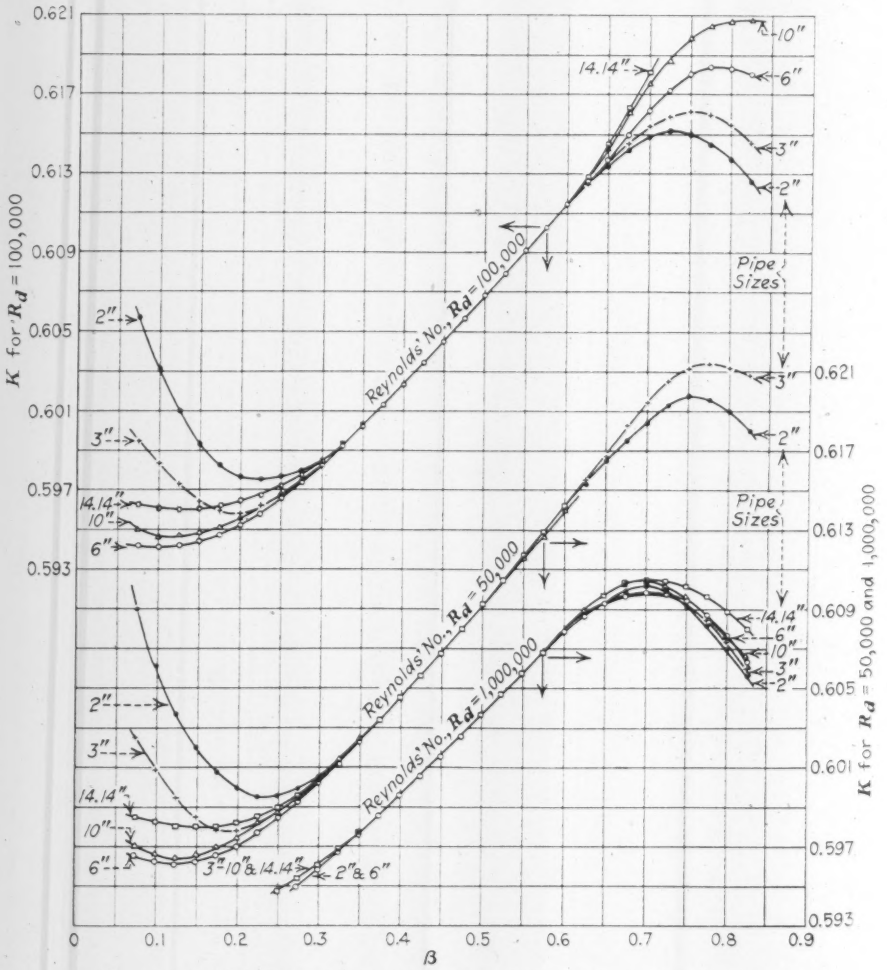


FIG. 2 DISCHARGE COEFFICIENTS FOR CONCENTRIC THIN-PLATE ORIFICES WITH VENA-CONTRACTA TAPS

(Data from "Fluid Meters," Part 1, 1937, A.S.M.E.)

K = discharge coefficient excluding the approach factor

D = inside diameter of pipe

β = diameter ratio = d/D

d = diameter of orifice

[9] Bailey Meter Company, Cleveland, Ohio. Mem. A.S.M.E.

cients were determined. In these experiments, long lengths of straight pipe preceded and followed the orifice, and the flow upstream from the orifice was substantially free from eddies, swirls, and disturbances. Consequently, to obtain accurate metering results from a flow in a commercial installation, care is needed to design the piping so that the orifice can function properly.

The A.S.M.E. Special Research Committee on Fluid Meters has recently published data[10] on orifice coefficients; it is of interest to review and evaluate these data.

Fig. 2 is a plot of the discharge coefficients for concentric orifices, using vena-contracta taps, for different pipe sizes and three constant values of Reynolds' number. These curves show that for diameter ratios ($\beta = d/D$) varying from 0.3 to 0.7 the discharge coefficient is practically independent of pipe size.

It is also apparent that within this range the data have a high order of accuracy and that small differences in geometric similarity exercise no appreciable effect on the flow similarity.

The branching of the curves outside the β range of from 0.3 to 0.7 is difficult to explain, especially in view of the behavior of the curve for the 6-in. pipe. But no doubt pipe roughness, wall effects, plate thickness, and the like exercised their influence to disturb the similarity conditions. Since these effects are difficult to evaluate quantitatively, it cannot be assumed without additional data that the values of the discharge coefficients obtained on either side of the β range from 0.3 to 0.7 will be exactly applicable to all pipes having the diameters indicated on the curves.

These curves bring out two important facts: First, that in the β range from 0.3 to 0.7 the present orifice-coefficient data are of a high order of accuracy; second, that more data are still needed outside this range, especially for large values of β.

The effects of disturbances such as fittings upstream from the primary element are understood in a general way. But actual data giving the quantitative effect on the discharge coefficient are meager. Much remains to be done, and before meter manufacturers can give the probable quantitative errors caused by disturbances, as requested by Mr. Van Duzer, these fields of flowmeter research must be explored systematically. The tests reported by G. Ruppel and H. Jordan[11] with expanding and reducing sections upstream from an orifice are a step in this direction. The data indicate that the error decreases with increasing Reynolds' numbers and decreasing diameter ratio. Also, the error remains substantially constant for Reynolds' numbers above 20,000 approximately for the smaller diameter ratios. They also show that the reducing section has a more stable effect than the expanding section and leads one to doubt the correctness of piping requirements presented for these sections on page 23 of Part 3 of the Fluid Meters Report, which gives the same piping requirements for both kinds of disturbances.

M. J. ZUCROW.[12]

[10] "Fluid Meters," Part 1, 1937, THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New York, N. Y.

[11] Forschung auf dem Gebiete des Ingenieurwesens, 1931, pp. 207–212.

TO THE EDITOR:

First, the author would like to thank all the discussers for their remarks, which have materially amplified the ideas he has attempted to present.

The two reasons given by Mr. Bean, as to why tables or curves have not been published giving approximate errors if all installation requirements are not complied with, are perhaps valid ones. The author has in mind, however, that the question of meter accuracy could be better evaluated from a cost standpoint by the user if the effects of the various installation precautions were listed. If such a tabulation were properly presented by the manufacturer, there seems little danger of misapplication. The result of tests to determine effects of different piping layouts, mentioned by Mr. Bean, will be awaited with interest.

The items discussed by Mr. Johnson serve to illustrate that the metering problems encountered in the industrial and smaller plants also should receive attention in the early stages of design to insure accuracy of flow measurements and ease of maintenance of the meter parts.

Mr. Reid's remarks regarding a knowledge of accurate piping costs for proper selection of pipe size for the metering section are quite true, particularly where alloy-steel piping is being considered. From a cost standpoint alone, it is only when an element of 331 in. differential is involved in a design that there is a possible opportunity to increase the size of the metering section and use the 212-in. body without increasing the piping cost. In the author's illustrations of the Conners Creek and Delray boiler leads, the high-head meter bodies were involved.

The author does not understand Mr. Reid's use of the term "fixed errors" in discussing the relative merits of the low- and high-head secondary elements. With a proper selection of D_2/D_1 and a well-designed secondary element, the percentage error in flow quantity should be approximately the same whether a low- or a high-head meter is used. One of the most accurate meters in use by the author's company is a low-head meter utilizing a head of 2 in. of water for the measurement of blast-furnace gas.

It is entirely possible that the measuring conditions, over the flow range of the installations mentioned by Professor Short, could be improved by the installation of straightening vanes or similar devices to eliminate swirls and eddies, thereby improving the velocity pattern. In this connection, Mr. Spink has brought out in his discussion the importance of straightening vanes in the elimination of swirl conditions where a suitable piping layout is not obtained. Anyone who is contemplating the use of such a device should ascertain that it is of rugged construction and securely fixed in the line. Vanes which were installed in two 14-in. turbine steam leads at one of the plants of the author's company in 1930 were found badly damaged in less than a year. The vibration set up by a steam velocity of 10,600 fpm was sufficient to crack and partly break the straightener that was installed.

Mr. Sprenkle's remarks concerning Fig. 1, as given in the paper, are of value in throwing further light on the subject of minimum piping requirements for the primary element. This is especially true of the condition shown in his Fig. 1 (*c*). The author is in agreement with him that the results of research work on correct piping layouts should be collected and published frequently by some such body as the A.S.M.E. Special Research Committee on Fluid Meters.

The remarks of Dr. Zucrow concerning orifice-plate coefficients are of value in illustrating the importance of selecting an orifice diameter ratio of 0.7 or lower. There is more certainty as to the correctness of the flow coefficient used for the meter design if such a selection is made. The author might mention that flow-nozzle data similar to those given in Dr. Zucrow's Fig. 2 are soon to be published by the A.S.M.E. Special Research Committee on Fluid Meters.

R. M. VAN DUZER, JR.[13]

[12] Consulting Engineer, Spitzglass and Zucrow, Chicago, Ill. Mem. A.S.M.E.

[13] The Detroit Edison Company, Detroit, Mich. Mem. A.S.M.E.

Legible Blueprints

TO THE EDITOR:

In the last five years a major change in drafting practice has taken place with the use of direct pencil-tracing-paper methods. Incorrect use of this system is the cause of practically all illegible blueprints.

A pencil drawing to be used as a tracing must have contrast in the various lines. The object and the dimension lines are frequently made with the same pencil, same pressure, and same point; cross-hatching lines, which should be as light as dimension lines, frequently are heavier than object lines; and center lines are used in place of cross-section cutting plane lines—an operation only tolerated when the center line is necessary to the drawing. Arrows pointing the direction of the cross section are apparently unknown to many draftsmen.

How can this difficulty be overcome? I find in my work that a 4H pencil, not too sharp, gives a good object line; a 6H pencil with a sharp conical point is suitable on dimensions, crosshatch, and center lines; a sharp conical-pointed 4H makes a contrasting dotted line; and a 2H with a conical point makes good cross-section lines, as well as being an easy pencil with which to letter and to make dimensions.

Many draftsmen go over the surface of a completed drawing with a soap eraser. This takes the life out of the contrast. It is better after cleaning a drawing to go over all the object lines to assure a hard thick layer of lead which is necessary to produce a good contrasting object line.

GUY C. CLOSE, JR.[14]

"Swan Song"

TO THE EDITOR:

As a "swan song" I have recently published my notes[15] on flowmetering with the usual head-type meters in an effort to make readily available to others in one place the more important relations. Thus I liquidate 20 years of work in this specialized field which I must leave to others because I am now a humble patent agent, and this profession takes all my time.

An attempt is made in these notes to investigate questions naturally occurring, to one taking a "sporting interest" in the subject in the order in which they naturally occur. The subject is by no means closed, and an effort has been made in the notes to indicate briefly the remaining unexplored frontiers. While they are not complete, the notes should make it possible for any engineer to reach a quick conclusion on any phase not covered, either by a study of the references which have been included largely for this purpose or by independently developing the treatment himself.

[14] Fairfield, Conn.

[15] Relations Involved in Metering Rate-of-Flow, *Instruments*, April, 1939, pp. 115–126.

In general, theoretical progress in this art has followed the publication of reliable experimental data rather than otherwise. At the present time, it would be most helpful if accurate data were to be published upon the results obtained when the several common taps are used in the same pipe, which need not be large, with the same set of orifices covering a wide range of diameter ratios to measure flow of both liquids and gases chosen to cover wide ranges of viscosities and specific-heat ratios. This should also be done with well-shaped nozzles. If well presented, such a work would be immediately welcomed as a classic like the well-known work of Stanton and Pannell on pipe friction. Also, effort should be put into developing an "ideal" nozzle shape for the different diameter ratios and its limitations established.

E. S. SMITH.[16]

Corrosion in Partially Dry Steam-Generating Tubes

TO THE EDITOR:

Helpfulness characterizes this paper.[17] It is constructive and practical, and deserves careful study by all operators of high-pressure boilers, as it does much to assist in the solution of a difficult operating problem of recent origin.

Like the embrittlement apparatus devised by Mr. Straub, this corrosion-testing equipment is ingenious and of high utility. Comparative results from equipment of this nature are obtained much quicker and easier than from actual boiler units, and can actually prove more useful because of better control of variables.

The effect of reducing agents in the boiler water would be a desirable subject of test with the apparatus. Some data on corrosion rate versus pH values from 5 to 11 might also prove helpful.

M. K. DREWRY.[18]

TO THE EDITOR:

The experimental work described in this paper fits together nicely with the experiences from plant operation presented in the writers' paper on this same program.[19] The conclusion reached by Messrs. Straub and Nelson—that if the metal temperature exceeds 750 F pure water will cause attack—should be given serious consideration even though experience in the field has indicated that corrosion along the ceiling of ash-screen tubes has been minimized by reducing the caustic alkalinity in the boiler water substantially to zero.

Merely as a matter of information the authors should indicate the approximate rate of heat transfer through the wall of their experimental tube in order that proper comparison may be made between the laboratory data and the plant experiences. By admittedly rough estimation the laboratory heat input should not exceed 40,000 Btu per sq ft per hr. The higher rates attained in actual boilers would tend to accentuate attack upon the steel in steam-blanketed regions and to reduce the chance of controlling this attack by modifying the composition of the boiler water.

One fact stands out pre-eminently: With waters of the most diverse composition, the tube surfaces, where continuously covered by water, remained in excellent condition even when the surfaces which were steam-blanketed suffered attack. This general conclusion surmounts in significance any of the variations noted in the separate experiments.

R. E. HALL.[20]
EVERETT P. PARTRIDGE.[20]

[16] C. J. Tagliabue Mfg. Co., Brooklyn, N. Y. Mem. A.S.M.E.

[17] "Corrosion in Partially Dry Steam-Generating Tubes," by F. G. Straub and E. E. Nelson, MECHANICAL ENGINEERING, March, 1939, pp. 199–202.

[18] Assistant Chief Engineer of Power Plants, Wisconsin Electric Power Company, Milwaukee, Wis. Mem. A.S.M.E.

[19] "Attack on Steel in High-Pressure Boilers as a Result of Overheating Due to Steam Blanketing," by E. P. Partridge and R. E. Hall.

[20] Director and Mem. A.S.M.E., and Director of Research, respectively, Hall Laboratories, Inc., Pittsburgh, Pa.

Control of Small-Plant Purchases

TO THE EDITOR:

The paper[21] by Mr. Zinck illustrates a point which the writer has had in mind for many years, that there are many types of factories in which the purchasing agent ought to be an engineer. The nature of the materials purchased and the way they are used in fabricating are such that an intimate knowledge of their composition and physical features is very important. There are a few concerns who have for many years had an engineer for this special purpose. In particular the De Laval Separator Company is recalled, which has had an engineer as purchasing agent for many years. Some of the railroads have such men. It is a point to which factory owners and managers could well give consideration.

ELMER H. NEFF.[22]

[21] Abstract in MECHANICAL ENGINEERING, November, 1938, p. 862.

[22] Brown & Sharpe Mfg. Co., New York, N. Y. Life Mem. A.S.M.E.

A.S.M.E. BOILER CODE

Use of Stainless Steels in Unfired Pressure Vessels

A SPECIAL subcommittee of the Boiler Code Committee, appointed to consider approval of new materials, has given extended consideration to the subject of use of stainless steels in pressure vessel construction, in an endeavor to formulate general rules. The problem has been found to be very involved and difficult, particularly as it is affected by the application of fusion welding in fabrication. Therefore, to meet the immediate needs of industry, the Boiler Code Committee proposes the following Cases for issuance, if found acceptable. They are submitted for public criticism and prompt comments are invited in order that they may be issued without undue delay.

It is expressly pointed out that these Cases are not to be considered effective until finally adopted by the Boiler Code Committee, notice of which will appear in MECHANICAL ENGINEERING. If anyone has any comments to offer, they should be submitted to the Secretary of the Boiler Code Committee, A.S.M.E., 29 West 39th Street, New York, N. Y.

CASE No. 836

In item (3)(*a*), change heat-treatment minimum temperature from "1900 F" to "1950 F."

CASE No. 861 (Reopened)

Inquiry: Case No. 834 covers Par. U-68 unfired pressure vessels of stabilized chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4. This material is now covered by A.S.T.M. Specifications A 167-38T, grade 5, for columbium-bearing and grade 9 for titanium-bearing material. Will it be permissible to apply the Code symbol stamp to unfired pressure vessels fabricated to Par. U-69 omitting the heat-treatment and special tests required in the reply to Case No. 834?

Reply: It is the opinion of the Committee that stabilized austenitic chrome-nickel steel, conforming to A.S.T.M. Specifications A 167-38T, grades 5 and 9, may be used for vessels constructed to Par. U-69 with the following limitations:

(1) The chemical composition and physical properties are modified as follows from A.S.T.M. Specifications A 167-38T, grades 5 and 9:

Carbon, max, per cent	0.07
Manganese, per cent	0.40–2.50
Chromium, min, per cent	17
Nickel, min, per cent	9.5
Columbium,* min = 10 times carbon content; 1 per cent max	
Titanium,* min = 6 times carbon content; 0.60 per cent max	
Tensile strength, min, lb per sq in.	75,000
Yield point, min, lb per sq in.	35,000
Elongation in 2 in., min, per cent	30

* Either columbium or titanium shall be used.

(2) Maximum temperature of 600 F; maximum pressure of 400 lb per sq in.; maximum thickness $^1/_2$ in.; allowable stress 15,000 lb per sq in., with a joint efficiency of 80 per cent.

(3) The last heating operation before welding shall consist of a softening treatment, that is, a heating to a minimum temperature of 1850 F, holding for not less than 1 hour per inch of thickness but in no case less than 30 minutes, and cooling rapidly and uniformly from that temperature. Heating after cold forming is not required.

Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions, or other corrosive environments, may fail by stress corrosion cracking. In order to take advantage of the omission of a stress relieving and stabilizing heat-treatment as covered by the preceding paragraphs of this reply, consideration should be given to the possibility of stress corrosion in the welds and affected zones.

(4) The composition of the deposited weld metal shall be within the following limits: The chromium and nickel content of the weld metal shall be within the same range as the parent metal; the columbium content of the weld metal, when columbium is used as a stabilizing element in the weld metal, shall be at least 9 times the carbon content of the weld metal and shall not exceed 1 per cent; the titanium content of the weld metal, when titanium is used as a stabilizing element of the weld metal, shall be at least 5 times the carbon content of the weld metal and shall not exceed 0.60 per cent. In case the chemical analysis of the first drillings of the weld metal fails to meet the foregoing specifications, two additional sets of drillings may be taken from the weld and the test shall be considered satisfactory if both these retest analyses meet the specifications.

(5) Vessels built under rules of Par. U-70 and otherwise conforming to the above limitations may be stamped accordingly but in this case the maximum allowable pressure shall not exceed 100 lb and the maximum service temperature shall not exceed 250 F. Allowable design stresses shall be 25 per cent greater than specified for carbon steel in U-70.

CASE A

The following new case is suggested:

Inquiry: Will it be permissible to apply the Code symbol stamp to unfired pressure vessels fabricated by fusion welding of chromium-nickel steels conforming to A.S.T.M. Specifications A167-38T, grades 2, 4, 6, if there is no heat-treatment following the welding?

Proposed Reply: It is the opinion of the Committee that austenitic chromium-nickel steel conforming to A.S.T.M. Specifications A 167-38T, grades 2, 4, and 6, may be used for vessels constructed to Par. U-69, with the following limitations:

(1) The chemical composition and physical properties shall be modified as follows: In all cases carbon 0.07 per cent maximum shall be required.*

In all cases manganese shall be specified as 0.40 to 2.50. Chromium and nickel content shall meet the minimum specified, but the exact range is subject to agreement between purchaser and manufacturer to obtain the optimum combination for the service. Tensile strength shall be 75,000 lb per sq in. minimum. Yield strength (0.2 per cent set) shall be 35,000 lb per sq in. minimum. Elongation in 2 in. shall be 30 per cent minimum.

(2) The last heating operation before welding shall consist of a full softening treatment, that is, heating to a minimum temperature of 1850 F for grades 2 and 4, and 1950 F for grade 6, holding for not less than 1 hour per inch of thickness but in no case less than 30 minutes, and cooling rapidly and uniformly from that temperature. Heating after cold forming is not required.

(3) Maximum service temperature shall be limited to 600 F; allowable working stress shall be 15,000 lb per sq in., with a joint efficiency of 80 per cent.

(4) Maximum thickness of the shell of these vessels shall not exceed $^3/_8$ in.

(5) Use of vessels constructed under the regulations of this inquiry shall be limited to service in which the prospective corrodents shall be none other than

* NOTE: The carbon analysis shall be considered to the nearest hundredth of one per cent.

steam or water, or to vessels in which the stainless steels shall be used to protect contents of the vessel from products of metallic corrosion rather than to prevent corrosion of the vessel itself.

Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions may fail by stress corrosion cracking. Consideration should be given to the possibility of stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed.

(6) Vessels built under the rules of Par. U-70 and otherwise conforming to the above limitations may be stamped accordingly, but in this case the maximum allowable pressure shall not exceed 100 lb and the maximum service temperature shall not exceed 250 F. Allowable design stresses shall be 25 per cent greater than specified for carbon steel in U-70.

CASE B

The following case is suggested:

Inquiry: In Case No. 836 permission is given to fabricate unfired pressure vessels by fusion welding of chrome-nickel-molybdenum steel conforming to A.S.T.M. Specifications A 167-38T, grade 6, in accordance with Par. U-68 with specific limitations as to composition, heat-treatment, and use. Is it permissible to use this same material for vessels constructed in accordance with Par. U-69, with the same limitations as to heat-treatment? Radiographing of the thinner wall vessels covered by this paragraph would seem to be unnecessary.

Proposed Reply: It is the opinion of the Committee that unfired pressure vessels fabricated of austenitic chrome-nickel-molybdenum steel conforming to A.S.T.M. Specifications A 167-38T, grade 6, will meet the intent of the Code, provided such vessels are constructed in accordance with Par. U-69 with the following limitations:

(1) The chemical composition and physical properties shall be modified as follows from A.S.T.M. Specifications A 167-38T, grade 6:

Carbon,* max, per cent	0.07
Manganese, per cent	0.40–2.50
Chromium and nickel content shall meet the minimum, the exact range being subject to agreement between purchaser and manufacturer to obtain the optimum combination for the service.	
Tensile strength, min, lb per sq in.	75,000
Yield point, min, lb per sq in.	35,000
Elongation in 2 in., min, per cent	30

* NOTE: The carbon analysis shall be considered to the nearest hundredth of one per cent.

(2) Maximum temperature, 600 F; allowable stress 14,000 lb per sq in., with a joint efficiency of 80 per cent.

(3) The complete vessel shall receive one of the two following heat-treatments:

(*a*) Heating to a minimum temperature of 1950 F, holding for a period of 1 hour per inch of thickness but in no case less than 15 minutes, and cooling rapidly and uniformly from that temperature.

It is important that internal stresses due to quenching be kept to a minimum in order to avoid stress corrosion. Therefore, the quenching should proceed as uniformly as possible, quenching from both sides wherever practicable and avoiding steam pockets by auxiliary cooling. The purpose of this heat-treatment is to provide maximum over-all corrosion resistance.

Austenitic chrome-nickel stainless steels, when in a condition of internal stress and exposed to certain aqueous chloride solutions may fail by stress corrosion cracking. Consideration should be given to the possibility of stress corrosion cracking in this and other corrosive environments to which the vessel may be exposed in cases where the vessels are to be quenched in accordance with the preceding paragraph.

(*b*) Heating to 1600–1650 F, holding sufficiently long to provide freedom from susceptibility to intercrystalline corrosion, and cooling in a still atmosphere.

The purpose of this heat-treatment is to place the vessel in a state of minimum internal stress.

(4) Production test plates similar to those required for Par. U-68 construction shall be made for each vessel or each 200 ft of weld in duplicate vessels and these test plates shall meet the welding process qualification requirements for Par. U-69 construction in carbon steel. These welded test plates shall be made from the same lot of material as the vessel itself. They shall be heat-treated with the vessels so as to duplicate as closely as possible the physical condition of the material in the vessel wall.

(5) The free-bend test specimen shall be ground and polished and the specimen immersed in boiling copper-sulphate sulphuric-acid solution for a minimum period of 48 hours. This solution shall consist of 47 cc concentrated sulphuric acid and 13 grams of crystalline copper sulphate ($CuSO_4.5H_2O$) per liter of water. After immersion, the samples shall be bent as specified in Par. U-68. The elongation on the outside fibers shall be not less than 20 per cent, at which there shall be no evidence of fissuring.

(6) Representative drillings of the weld metal shall be obtained from one of the welded test plates and the chemical analysis of the weld metal shall be within the same range as the parent metal. In case the chemical analysis of the first drillings of the weld metal fails to meet the foregoing specifications, two additional sets of drillings may be taken from the same welded test plate, and the test shall be considered satisfactory, if both these retest analyses meet the specifications.

(7) The above provisions may be applied also to chrome-nickel-molybdenum steel as covered above with columbium or titanium additions. Vessels of chrome-nickel molybdenum steel of the composition and physical properties covered by (1), where the columbium or titanium content is a minimum of 60 per cent of that required in the reply to Case No. 834, may be constructed in accordance with the requirements of this case.

The lower columbium and titanium content permitted for the chrome-nickel-molybdenum steel is due to the stabilizing effect of the molybdenum content.

CASE C

The following case is suggested:

Inquiry: In Case No. 834 permission is given to fabricate unfired pressure vessels by fusion welding of chrome-nickel steel conforming to A.S.T.M. Specifications A 167-35T, grade 4, stabilized with columbium or titanium, in accordance with Par. U-68 with specific limitations as to composition, heat-treatment, and use. This material is now covered by A.S.T.M. Specifications A 167-38T, grade 5 for columbium-bearing, and grade 9 for titanium-bearing material. Is it permissible to use this same material for vessels constructed in accordance with Par. U-69 with the same limitations as to heat-treatment? Radiographing of the thinner wall vessels covered by this paragraph would seem to be unnecessary.

Proposed Reply: It is the opinion of the Committee that unfired pressure vessels fabricated of austenitic chrome-nickel steel conforming to A.S.T.M. Specifications A 167-38T, grades 5 and 9, will meet the intent of the Code, provided such vessels are constructed in accordance with Par. U-69 with the following limitations:

(1) The chemical composition and physical properties shall be modified as follows from A.S.T.M. Specifications A 167-38T, grades 5 and 9:

Carbon, max, per cent	0.07
Manganese, per cent	0.40 to 2.50
Chromium, per cent	at least 17
Nickel, per cent	at least 9.5
Tensile strength, min, lb per sq in.	75,000
Yield point, min, lb per sq in.	35,000
Elongation in 2 in., min, per cent	30

(2) Maximum temperature 700 F; al-

lowable stress 15,000 lb per sq in., with a joint efficiency of 80 per cent.

(3) The complete vessel shall be heat-treated as follows:

A vessel of columbium-bearing steel shall be treated at a temperature not less than 1550 F and held at that temperature for a period of time proportioned on the basis of at least 1 hour per inch of thickness, but in no case less than 2 hours. A vessel of titanium-bearing steel shall be treated at a temperature not less than 1550 F and not to exceed 1650 F and held at that temperature for a period of time proportioned on the basis of at least 1 hour per inch of thickness but in no case less than 4 hours. The complete vessel shall be heat-treated as a unit, no local stress relieving being permitted, and it shall be allowed to cool slowly in a still atmosphere.

(4) Production test plates similar to those required for Par. U-68 construction shall be made for each vessel or each 200 ft of weld in duplicate vessels and these test plates shall meet the welding process qualification requirements for Par. U-69 construction in carbon steel. These welded test plates shall be made from the same lot of material as the vessel itself. They shall be heat-treated with the vessels so as to duplicate as closely as possible the physical condition of the material in the vessel wall.

(5) The free-bend test specimen shall be ground and polished and the specimen immersed in boiling copper sulphate sulphuric acid solution for a minimum period of 48 hours. This solution shall consist of 47 cc concentrated sulphuric acid and 13 grams of crystalline copper sulphate ($CuSO_4.5H_2O$) per liter of water. After immersion, the samples shall be bent as specified in Par. U-68. The elongation on the outside fibers shall be not less than 20 per cent, at which there shall be no evidence of fissuring.

(6) Representative drillings of the weld metal shall be obtained from one of the welded test plates and the chemical analysis of the weld metal shall be within the same range as the parent metal. In case the chemical analysis of the first drillings of the weld metal fails to meet the foregoing specifications, two additional sets of drillings may be taken from the same welded test plate, and the test shall be considered satisfactory if both these retest analyses meet the specifications.

Books Received in Library

ALGEBRAISCHE KURVEN. By H. Wieleitner. Part 2. Allgemeine Eigenschaften. Sammlung Göschen, Band 436. Walter de Gruyter & Co., Berlin, 1939. Cloth, 4 × 6 in., 122 pp., diagrams, tables, 1.62 rm. The general properties of the more important algebraic curves are set forth in this small volume, including a discussion of points of intersection and polar properties.

DAS AUFBAUPRINZIP DER TECHNIK. By P. Wessel. Ernst Reinhardt, Munich, 1937. Paper, 6 × 9 in., 39 pp., diagrams, 1.50 rm. This simple presentation of basic technological concepts considers also the elementary application of analysis and synthesis to technical problems and design.

ATM (Archiv für technisches Messen), Lieferungen 91–93, January, February, March, 1939. R. Oldenbourg, Munich and Berlin. Paper, 8 × 12 in., illus., diagrams, charts, tables, 1.50 rm each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

BENDING STRESSES IN THE MEMBERS OF A TRUSS DUE TO THE RIGID CONNECTIONS AT THE JOINTS. By I. A. El Demirdash. A. G. Gebr, Leemann & Co., Zurich, Switzerland, 1937. Paper, 6 × 9 in., 55 pp., diagrams, charts, tables. This is a rewritten and somewhat condensed account of a research carried out by the author during 1928 to 1930 and originally published in German as a bulletin of the Institut für Baustatik. It describes an exact method for calculating stresses in triangular frameworks, with which the author compares unfavorably the Mohr method.

BRAKING POWER AND HOW FIGURED ON FREIGHT AND PASSENGER CARS. By F. A. Chilton. F. A. Chilton, 274 Polk St., or Shelton-Turnbull-Fisher Co., 44 West 10th Ave., Eugene, Oregon, 1938. Cardboard, 5 × 8 in., 126 pp., diagrams, tables, $1.75. This book gives practical, simple directions for calculating the braking power of railway cars, intended for use by railway shopmen. Numerous problems are worked out to illustrate the method, which can also be used to calculate the lifting power of pneumatic jacks and hoists.

CHEMICAL INDUSTRIES, edited by D. M. Newitt. Chemical Publishing Co., New York, 1939. Cardboard, 9 × 11 in., 380 pp. and bibliography, 79 pp., illus., diagrams, charts, tables, $4. This annual contains a collection of numerical data and information frequently wanted by those in the process industries, accompanied by directories of British manufacturers of supplies and equipment. The subjects considered are materials of construction, power plant, and water treatment, factory equipment and layout, size reduction, separating and grading, handling and transporting, instruments and apparatus, raw materials, fine chemicals, conversion tables, books.

DER DAMPFBETRIEB DER SCHWEIZERISCHEN EISENBAHNEN. By A. Moser. Second edition. Verlag Birkhäuser, Basel, 1938. Cloth, 9 × 12 in., 394 pp., illus., diagrams, charts, tables, 22 Swiss fr. This work is a valuable addition to the history of the locomotive. In a detailed fashion, the history of practically every Swiss locomotive is traced, from the opening of the first Swiss railway in 1847 down to the year 1936, when these roads were largely electrified. Numerous photographs and drawings add to the usefulness of the book. Standard, narrow-gage and rack locomotives, and railway motor cars are covered.

DAVISON'S RAYON AND SILK TRADES, the Standard Guide, 44th annual, 1939, pocket edition. Davison Publishing Co., Ridgewood, New Jersey. Cloth, 5 × 8 in., 456 pp., illus., maps, thin-paper pocket edition, $5.50; de luxe office edition, $7.50. A directory of mills, dyers, and finishers in the rayon and silk trades, containing both geographical and classified lists, as well as an alphabetical index. A buyers' guide indicating sources for equipment, and the railroad serving the various plants.

DECLINE OF MECHANISM (in Modern Physics). By A. d'Abro. D. Van Nostrand, New York, 1939. Cloth, 6 × 9 in., 982 pp., diagrams, tables, $10. This book reviews the historical development of physical theories from their beginnings to the modern quantum theory. Particular stress is laid on Heisenberg's "principle of uncertainty," and on the reasons which compelled physicists to abandon mechanical interpretations. The three parts of the book deal, respectively, with the fundamentals of natural philosophy, with a review of mathematics and the more important classical physical theories, and with a discussion of the various quantum theories and the doctrine of causality.

DEUTSCHE KRAFTFAHRTFORSCHUNG im Auftrag des Reichs-Verkehrsministeriums. Heft 14: Dauerhaltbarkeit von Stahl- und Gusskurbelwellen, by K. Bandow. 35 pp., 3.75 rm. Heft 15: Wellenförmige Reifenabnutzung, by H. P. Zoeppritz and L. Huber. 17 pp., 1.90 rm. Heft 16: Pendelerscheinungen an Strassen-Anhängerzügen, by O. Dietz. 47 pp., 4.85 rm. Heft 18: Luftwiderstand von Krafträdern, by E. Sawatzki and L. Huber. 10 pp., 1.15 rm. Heft 19: Schwingungen auf der Ansaugseite von Zweitaktmotoren mit Kurbelkastenpumpe, by U. Schmidt. 8 pp., 0.95 rm. Heft 20: Gestaltung und Dauerhaltbarkeit von geschlossenen Stabköpfen und ähnlichen Bauteilen, by A. Thum and E. Bruder. 10 pp., 1.15 rm. Berlin, V.D.I. Verlag, 1938–1939. Paper, 8 × 12 in., illus., diagrams, charts, tables. These six publications on automotive research cover a diverse group of topics: Fatigue resistance of crankshafts; tests of tire wear; oscillatory phenomena in trailer operation; air resistance of motorcycles with varied streamlining; suction-side vibrations of a two-cycle motor compared with the outlet side; and fatigue resistance of connecting rod heads and similar machine elements.

DAS DEUTSCHE SCHRIFTTUM ÜBER VORRICHTUNGEN für den Ausschuss für Vorrichtungen bei der Arbeitsgemeinschaft deutscher Betriebsingenieure (ADB) des V.D.I. Collected by A. Paech. V.D.I. Verlag, Berlin, 1938. Paper, 6 × 8 in., 114 pp., 3 rm. Some 1800 titles are listed in this classified bibliography, covering all phases of precision machine-tool work, both general and specific. The references listed are mainly from the important German magazines in the field, within the last twenty years.

DIESEL ENGINES, Theory and Design. By H. E. Degler. American Technical Society, Chicago, 1939. Cloth, 6 × 9 in., 270 pp., illus., diagrams, charts, tables, $2.50. A

practical elementary text which uses only elementary mathematics, intended for evening-school classes and home study. Thermodynamics, fuels and combustion, and testing are considered, together with the principles of design and the design of engine parts.

ECONOMICS OF BUSINESS ENTERPRISE. By W. Rautenstrauch. John Wiley & Sons, New York, 1939. Cloth, 6 × 9 in., 445 pp., diagrams, charts, tables, $4. The objects of this book are to describe what is generally considered to be good practice in dealing with the economic problems of specific business enterprises, to inquire into the theories on which these practices rest, and to develop methods of analysis with which to deal more intelligently with the economic problems of a given business. The final chapter treats in general of business enterprise on a national scale.

ELEMENTS OF PRACTICAL AERODYNAMICS. By B. Jones. Second edition. John Wiley & Sons, New York, 1939. Cloth, 6 × 9 in., 436 pp., illus., diagrams, charts, tables, $3.75. This simple exposition of the fundamentals of aerodynamics for beginning students relates mainly to airplane practice, and includes brief information on materials and construction, instruments and avigation. A long glossary and a set of answers to the problems given in the book are appended.

LES GAZOGÉNES, Théorie, Pratique, Contrôle. By H. Guillon. Chaleur et Industrie, Paris, 1939. Paper and bound, 6 × 9 in., 126 pp., diagrams, charts, tables, paper 30 fr.; bound, 50 fr. Following a discussion of the principles of the gasification of solid fuels, the author gives practical information concerning the various types of gas producers and their operating characteristics, and their regulation, and describes producers for various special purposes.

GESCHICHTE DER MATHEMATIK. By H. Wieleitner. Vol. 1. (Sammlung Göschen, Band 226.) 136 pp. Vol. 2. (Sammlung Göschen, Band 875.) 154 pp. Walter de Gruyter & Co., Berlin, 1939. Cloth, 4 × 6 in., 1.62 rm per vol. The first of these two small volumes carries the history of mathematics from the days of ancient Greece and Rome, through the Indian and Arabian contributions, to the end of the seventeenth century, including the beginning of the newer conceptions such as the use of infinitesimals. In the second volume the development is surveyed by branches through the first half of the nineteenth century.

GLASS FACTORY YEAR BOOK AND DIRECTORY. 1939 edition. American Glass Review, Pittsburgh, Pa. Paper, 6 × 8 in., 160 pp., tables, loose leaf, $5. Complete data on all manufacturers of glass products in the United States and Canada are given in this annual compendium. Also included are classifications of glass products, indexes of raw materials, equipment, finished products and manufacturers, and some statistical and technical information.

HANDBUCH DER ROHRLEITUNGEN. By F. Schwedler. Second edition. Edited with assistance of H. von Jürgensonn. Julius Springer, Berlin, 1939. Cloth, 6 × 10 in., 253 pp., illus., diagrams, charts, tables, 33 rm. This is a general treatise upon the design and construction of pipe lines for power plants, heating plants, gas and water works, petroleum, etc. The first section describes the varieties of pipe lines for various purposes. Section two discusses design, pressure and heat losses, and strength. The third section describes the elements of lines. There is a bibliography.

HIGHER MATHEMATICS. By R. S. Burington and C. C. Torrance. McGraw-Hill Book Co., 1939. Cloth, 6 × 9 in., 844 pp., diagrams, charts, tables, $5. Designed primarily to meet the needs of students interested in the applications of mathematics to physics and engineering, the concepts presented have been developed with sufficient rigor to be suitable as well for students of pure mathematics. In the following topics the physical meanings of the various notations and relationships have been emphasized, with the help of numerous examples and exercises: advanced differential and integral calculus; differential equations; infinite series; functions of a complex variable; vector analysis; and the calculus of variations.

HYDRAULICS for Engineers and Engineering Students. By F. C. Lea. Sixth edition. Longmans, Green & Co., New York, 1938. Cloth, 6 × 9 in., 757 pp., illus., diagrams, charts, tables, $6.75. The opening chapters deal with the basic characteristics of fluids at rest and in motion. The several chapters following contain a detailed analysis of the flow of water over weirs, through orifices and pipes, and in open channels, as well as of gaging practice. A chapter on the impact of water on vanes is introductory to the description and analysis of water wheels, turbines, centrifugal and reciprocating pumps, and other hydraulic machines. Streamline motion and dynamical similarity are briefly discussed.

INCHLEY'S THEORY OF HEAT ENGINES. Edited and revised by H. W. Baker. Longmans, Green & Co., New York and London, 1938. Cloth, 6 × 9 in., 445 pp., diagrams, charts, tables, $3.60. Considerably changed from the original book, this new edition retains the author's idea "to give in a complete and concise form the thermodynamical principles of the subject." These principles, first the fundamental general ones and then the more specific applications, are considered, respectively, before the discussion of the particular devices treated: air compressors and motors, reciprocating steam engines, steam turbines, internal-combustion engines, and mechanical refrigerators. Heat transfer, combustion, and test methods are also included.

INDEX TO A.S.T.M. STANDARDS AND TENTATIVE STANDARDS, January, 1939. American Society for Testing Materials, Philadelphia, 1939. Paper, 6 × 9 in., 129 pp., free upon application. This index is a convenient guide to the current state of standardization by the Society, as it indexes all the specifications, test methods, and definitions now in force, regardless of the volumes in which they appear. Over eight hundred specifications are indexed under appropriate headings.

KLINGELNBERG TECHNISCHES HILFSBUCH, edited by E. Preger and R. Reindl. Ninth revised edition. Julius Springer, Berlin. Cloth, 5 × 7 in., 706 pp., illus., diagrams, charts, tables, 10.50 rm. This handbook was formerly issued under the name of Schuchardt and Schuette. It is intended as a reference book for designers and machine builders, and provides a well-selected, up-to-date collection of data, standards, and practical information on shop practice and machine design. A number of specialists have collaborated with the editors. References are appended to the different chapters.

LIGHT. By F. Bray. Second edition. Edward Arnold & Co., London; Longmans, Green & Co., New York, 1938. Cloth, 5 × 8 in., 369 pp., illus., diagrams, charts, tables, $2.50. The field of optics is covered quite fully in this elementary textbook, the subject matter varying from the fundamental phenomena of propagation, reflection, and refraction, through description of the eye and various optical instruments, to discussions of diffraction, polarization and, spectra. Questions with answers are included.

MACHINERY'S HANDBOOK FOR MACHINE SHOP AND DRAFTING ROOM. By E. Oberg and F. D. Jones. Tenth edition. Industrial Press, New York, 1939. Leather, 5 × 7 in., 1815 pp., diagrams, charts, tables, $6. This well-known work of reference is intended to assist the designing and manufacturing departments of machine-building plants by providing mechanical data and general information upon current practice. This edition has been revised. It contains 250 pages more than the previous one.

MACHINING OF METALS. By H. Ernst, H. B. Knowlton, J. W. Bolton, A. H. d'Arcambal, W. E. Bancroft, and H. P. Croft. American Society for Metals, Cleveland, 1938. Leather, 6 × 9 in., 177 pp., illus., diagrams, charts, tables, $2.50. The five lectures collected in this volume were presented to the American Society for Metals. The topics considered include the physics of metal cutting, the machinability of various irons and steels, and the machining of nonferrous metals. Numerous photomicrographs illustrate the text material.

MÉCANIQUE DES FLUIDES APPLIQUÉE, two volumes. By A. Tenot, with preface by A. Caquot. Dunod, Paris, 1939. Paper and bound, 5 × 9 in., diagrams, charts, tables. Vol. 1, 226 pp., bound, 64 fr.; paper, 56 fr. Vol. 2, 147 pp., bound, 50 fr.; paper, 42 fr. These are the first two books of four which are to be devoted to presenting practical applications of the laws of fluid mechanics. A variety of problems met in the design of turbines, pumps, and aircraft, and in viscosimetry and lubrication, are worked out in numerical examples. These selected problems offer practical experience in applying theories to concrete cases.

METAL SPRAYING. Second edition, revised and largely rewritten by E. C. Rollason, first edition written by T. H. Turner and N. F. Budgen. J. B. Lippincott Co., Philadelphia and New York, 1939. Leather, 6 × 9 in., 235 pp., illus., diagrams, charts, tables, $7.50. This book supplies a comprehensive outline of practice in metal spraying. The history of the process is outlined and current types of pistols are described. Surface preparation is discussed the nature of sprayed metal considered, and the process compared with other methods of metallization. A chapter is devoted to applications. There is a bibliography.

METHODS OF STATISTICAL ANALYSIS. By C. H. Goulden. John Wiley & Sons, New York, 1939. Cloth, 6 × 9 in., 277 pp., diagrams, charts, tables, $3.50. Designed for the student who intends to do practical research work in the biological sciences, this book presents methods and actual examples for the handling of statistical material in these fields. Considerable discussion of principles and theory is included, coordinated, however, with the direct application of these principles.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN DES GHH-Konzerns, Bd. 7, Heft 1, January, 1939. V.D.I. Verlag, Berlin. Paper, 8 × 12 in., 22 pp., illus., diagrams, charts, tables, 2.90 rm. The two articles contained in this contribution are concerned, respectively, with the structure of stress-relief-annealed boiler-plate welds, including a comparison with normalized welds, and with the problem of designing Diesel motor parts so that the critical value for torsional vibration will not fall within the operating range.

MITTEILUNGEN DES WÖHLER-INSTITUTS, Braunschweig. Heft 35. Die Dämpfung von Drähten, by H. Lüttgerding. Von was hängen Fliessbeginn und Bruchfestigkeit eines Werkstoffes ab? By O. Föppl. Friedr. Vieweg & Sohn, Braunschweig, 1939. Paper, 6 × 8 in., 70 pp., illus., diagrams, charts, tables, 4 rm. The first of the two articles in this pamphlet describes an investigation of the damping properties of wires of various materials carried out with several oscillatory torsion-testing machines, and includes a critical evaluation of the results. The second article discusses those properties and characteristics of materials upon which their yield point and ultimate strength depend.

NEUGESTALTUNG DER INDUSTRIESTATISTIK. Eine wehrwirtschaftliche Forderung. By K. Pechartscheck. V.D.I. Verlag, Berlin, 1939. Paper, 6 × 8 in., 30 pp., maps, charts, diagrams, 3.50 rm. The present European situation is reflected in this recent pamphlet dealing with the relation of industrial statistics to defense measures. The author shows the importance of the accurate compilation of information concerning material supplies, productive capabilities, number and location of industries, labor supply, etc., for the most efficient use of a nation's resources under governmental control.

PHYSICAL SCIENCE IN MODERN LIFE. By E. G. Richardson. D. Van Nostrand Co., New York, 1939. Cloth, 5 × 8 in., 256 pp., illus., diagrams, $3. A well-written account, intended for the general reader, of some recent developments in physics, is provided by this book. The author has chosen subjects which touch our everyday existence. Streams and eddies, vibrations and waves, colloids, heat, light, electricity, sensation, and reaction are among the matters considered.

PIPE CORROSION AND COATINGS. By E. Larson and G. I. Rhodes. American Gas Journal, New York, 1938. Cloth, 6 × 9 in., 455 pp., illus., diagrams, charts, tables, $2.50. In this volume the author has collected, coordinated, and explained the various theories of corrosion and of pipe protection, in particular with respect to external corrosion of underground gas-pipe lines. Soil testing, the making of corrosion surveys, the types of protective coating, and the methods of applying them are covered in detail, and there is a chapter on cathodic protection.

POWER-FACTOR ECONOMICS. By P. L. Rogers. John Wiley & Sons, New York, 1939. Cloth, 6 × 9 in., 143 pp., illus., diagrams, charts, tables, $2.50. The aim of this book is to answer the questions that arise when power factor is considered and to provide simple, accurate means for solving power-factor problems. The larger part of the book is devoted to industrial plants, but a section is also included on the distribution systems of public utilities. The data required for the solution of problems is included, and typical problems are solved as illustrations.

PRACTICAL ACCOUNTING FOR OIL PRODUCERS. by R. M. Pitcher. Mid-West Printing Co., Tulsa, Okla., 1938. Leather, 6 × 9 in., 370 pp., charts, tables, $5. All phases of oil-production accounting are covered in detail with many illustrations of forms for various uses. Extracts from the American Petroleum Institute Uniform System of Accounts for the Oil Industry are appended, as are also certain special procedures and contracts. There is a short glossary of oil-field terms and a special index of forms, in addition to the customary subject index.

PRACTICAL HEAT. Edited by T. Croft, revised by R. B. Purdy. Second edition. McGraw-Hill Book Co., New York and London, 1939. Cloth, 6 × 8 in., 726 pp., illus., diagrams, charts, tables, $5. This book is intended to provide a textbook on heat which can be used by those with no mathematical equipment other than arithmetic. The fundamental laws of heat phenomena, the effects of heat, and the properties of vapors are explained in the theoretical sections. These are followed by sections on the practical applications of heat phenomena in steam and internal-combustion power plants, building heating, and refrigeration. Numerous examples and problems are given. In this edition the practical sections have been thoroughly revised.

PROCEEDINGS OF THE SIXTH SUMMER CONFERENCE ON SPECTROSCOPY AND ITS APPLICATION, a publication of the Technology Press, Massachusetts Institute of Technology. John Wiley & Sons, New York, N. Y., 1939. Paper, 8 × 10 in., 172 pp., illus., diagrams, charts, tables, $3. The 31 papers contained in this publication, somewhat condensed from the form in which they were presented, demonstrate the circle range of application of spectroscopic investigation and describe various advances in the technique of spectroscopy.

PROTECTIVE COATINGS FOR METALS. American Chemical Society Monograph Series No. 79. By R. M. Burns and A. E. Schuh. Reinhold Publishing Corp., New York, 1939. Cloth, 6 × 9 in., 407 pp., illus., diagrams, charts, tables, $6.50. This volume, originally intended as a revision of Rawdon's "Protective Metallic Coatings," has been expanded into a new work which includes protective coatings of all types. The book supplies a comprehensive review of our knowledge of the prevention of corrosion by metallic coatings, paints, oxide films, etc.

SECOND REPORT ON VISCOSITY AND PLASTICITY, prepared by the Committee for the Study of Viscosity of the Academy of Sciences at Amsterdam. N. V. Noord-Hollandsche Uitgeversmaatschappij, Amsterdam; Nordemann Publishing Co., New York, 1938. Cloth, 7 × 11 in., 282 pp., illus., diagrams, charts, tables, $7.50. The first report of this Committee appeared in 1935. The second report includes surveys of further developments treated in the first, and also a discussion of problems concerning the internal structure of liquids. Among the topics considered are the relation of the viscosity of liquids to their chemical and physical constitution, the motion of small elongated particles in a viscous liquid, the yield value, recent plastometers, and technical capillary viscosimeters. The book gives a good summary of current knowledge and theories.

SOUTH TEXAS OIL, published by Rinehart Oil News Co., Houston, Texas, 1938. Paper, 9 × 11 in., 112 pp., maps, $7.50. This publication gives a factual account of conditions in this oil field. A brief history of its development, a description of the trends, present developments and prospects, and a review of the geology of the district form the general text. There is also included a directory of the refineries, gasoline plants, and producing wells in the region, with data concerning ownership, production, depth, etc. A map showing the fields is given.

SPECTROGRAPHIC ANALYSIS IN GREAT BRITAIN. Edited by A. C. Candler. Adam Hilger, Ltd., London, 1939. Linen, 6 × 10 in., 80 pp., charts, tables, 7s 6d. As an indication of the increasing use of the spectrograph in British industry this record of some of the purposes served by spectrochemical analysis is presented. Although metallurgical analyses are preponderant, references are given to use in the glass, paint, and textile industries, agricultural research, art, archaeology, and crime detection.

STREAM AND CHANNEL FLOW (Hydraulic Graphs and Tables). By E. E. Morgan, with a foreword by C. L. H. Humphreys. Chapman & Hall, London, 1938. Cloth, 6 × 9 in., 240 pp., tables, charts, 25 s. This volume contains a collection of graphs and tables prepared to facilitate calculations relating to the uniform flow of water in open channels and streams. The graphs and the greater part of the book are based on Manning's formula. A comparative study of various formulas is included. The tables are designed to enable problems of velocity and discharge to be solved quickly and their use is illustrated by examples.

SUPERHEATER IN MODERN POWER PLANT. By D. W. Rudorff. Sir Isaac Pitman & Sons, London; Pitman Publishing Corp., New York, 1938. Cloth, 6 × 9 in., 293 pp., illus., diagrams, charts, tables, $6. The chief object of this book is to present actual ways and means of superheating saturated steam, and for this reason most of the chapters contain descriptive material concerning various types of superheaters. There are also chapters on superheater computation and regulation and on the mechanical design and operation of superheaters. Superheated steam tables are appended. The book is based on a series of articles which appeared in *Engineering* and *Boiler House Review*.

SYNTHETIC PROJECTIVE GEOMETRY. By R. G. Sanger. McGraw-Hill Book Co., New York and London, 1939. Cloth, 6 × 8 in., 175 pp., diagrams, $2. Developing projective geometry by methods used in high-school geometry, this elementary text first treats completely the projective aspects of the various phases of the subject and then makes specializations which relate the new geometry to classical metric plane geometry.

TABLES D'INTÉGRALES DES DIFFÉRENTIELLES USUELLES. By H. Pecheux. Dunod, Paris, 1939. Paper, 6 × 8 in., 73 pp., charts, diagrams, tables, 25 fr. This manual opens with a brief résumé of the fundamentals of differentiation and integration, after which tables of various differentials are presented with an indication of the method of integration and the indefinite integral thus achieved. Examples of applications to practical problems in mechanics and electricity are included.

LA TECHNIQUE DE L'ÉCLAIRAGE DES AUTOMOBILES. By A. Monnier and M. Mouton. Dunod, Paris, 1939. Paper and bound, 7 × 10 in., 223 pp., illus., diagrams, charts, tables; paper, 68 fr.; bound, 88 fr. In addition to discussing the theoretical and practical aspects of automobile headlights with reference to reflectors, lenses, lamps, and so on, considerable space is devoted to the careful consideration of varying atmospheric conditions and the use of colored light as to propagation, visibility, and physiological effect. Polarized light is treated briefly.

THEORY OF LUBRICATION. By M. D. Hersey. John Wiley & Sons, New York, 1938. Cloth, 6 × 9 in., 175 pp., diagrams, charts, $2.50. The purpose of this book is to give a balanced picture of the scientific background of modern lubrication, so that the problems that arise in practice may be better understood. The topics considered are viscosity, the hydrodynamical and dimensional theories, tempertaure rise in bearings, and the problem of oiliness. A section on recent developments has been added to this edition. Good bibliographies accompany each section.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

San Francisco Offers Varied Program of Events for A.S.M.E. Semi-Annual Meeting, July 10–15

Includes Technical Sessions, World's Fair, Engineers' Day, Rice Lecture, Banquets, and Visits to Plants and Ships

SAN FRANCISCO SECTION, on behalf of its members, the city on the Golden Gate, and the World's Fair of the West, takes this last opportunity to extend a cordial invitation to all A.S.M.E. members and their friends to take part in the 1939 Semi-Annual Meeting of The American Society of Mechanical Engineers to be held in this metropolis of the West, July 10–15, with headquarters at the Fairmont Hotel. E. M. Breed, chairman of the committee for the meeting, assures every one that nothing has been left undone to make this national meeting of the Society and the fourth to be held by the A.S.M.E. in San Francisco, earlier meetings having taken place in 1892, 1915, and 1926, the most complete in technical sessions, banquets, luncheons, entertainment, and, most important of all, good fellowship.

In addition, as added incentives for coming West, there are the opportunities for the meeting participants to visit the Pacific Fleet of the U. S. Navy which will be anchored in San Francisco Bay during the A.S.M.E. meeting, and to look over the World's Fair of the West, officially called the Golden Gate International Exposition, on Treasure Island. In honor of the visiting engineers, the officials of the Exposition have designated July 13 as "Engineers' Day," which following a concert by the Exposition Band, will feature an address in the morning by Herbert Hoover, honorary member of the A.S.M.E. At the banquet in the evening at the California Building on Treasure Island, Dr. Rodolfo E. Ballester, director of the Argentine Department of Irrigation, and the official representative of the Republic of Argentina at the A.S.M.E. Meeting, will present the fifth Calvin W. Rice Lecture.

Contrary to usual practice, the committee has scheduled only one plant trip; however, other trips to the many diversified industries of San Francisco and Oakland, the university laboratories, and various water projects are to be arranged during the meeting at the request and convenience of the visitors. Another standard function, the official women's program, has been discarded in favor of informal entertainment by members of the Women's Committee, and of local shopping trips or sight-seeing tours, whenever and to whatever extent the visitors express their wishes.

Two Changes Are Made on the Technical-Sessions Program

The program for the 1939 A.S.M.E. Semi-Annual Meeting, which was published in the June, 1939, issue of MECHANICAL ENGINEERING on page 481, remains the same except for two slight changes. The first is the transfer of the Agricultural Engineering sessions from Wednesday morning, July 12, to Friday morning, July 14, and the shift of the Oil and Gas Power session from Friday to Wednesday morning.

World's Fair Designates July 13 as Engineers' Day

Participants of the A.S.M.E. 1939 Semi-Annual Meeting will probably spend a lot of time at the World's Fair of the West on Treasure Island, which has been described in detail in previous issues of MECHANICAL ENGINEERING and in the daily press. Furthermore, the committee has not scheduled any technical sessions for Thursday, July 13, so that all may accept the invitation of the officials of the Golden Gate International Exposition to celebrate "Engineers' Day" at the Fair on Treasure Island. The program for the day is as follows:

10:30 a.m. The Stadium
Concert by Exposition Band
Address to be delivered by Herbert Hoover, honorary member A.S.M.E., on "Engineering Contributions to Human Welfare."

AERIAL VIEW OF COLUMBIA STEEL COMPANY PLANT, PITTSBURG, CALIF., TO WHICH AN EXCURSION IS PLANNED DURING A.S.M.E. SEMI-ANNUAL MEETING

Afternoon

Inspection of industrial and engineering exhibits at the Fair

6:00 p.m. California Building

Banquet (informal) and presentation of the fifth Calvin W. Rice Lecture by Dr. Rodolfo E. Ballester, director of the Argentine Bureau of Irrigation, on the topic of "Economical and Technical Aspects of Argentina"

"An Engineer Looks at the Engineers" at Tuesday Banquet

W. F. Durand, honorary member and past-president of the A.S.M.E., will act as toastmaster at the 1939 Semi-Annual Meeting banquet to be held at the Fairmont Hotel on Tuesday evening, July 11. The speaker of the evening will be F. T. Letchfield, member A.S.M.E., and consulting engineer and assistant vice-president of the Wells Fargo Bank & Union Trust Co. His paper, which is entitled "An Engineer Looks at the Engineers," will discuss the history and growth of the engineering profession, its fundamental contributions to human progress, the characteristics which set it apart from other professions, its responsibilities to society, and a brief estimate of its future. President Christie will speak briefly on "The Trend of Mechanical Engineering."

Argentine Engineer to Give Calvin W. Rice Lecture

One of the high lights of the 1939 Semi-Annual Meeting of the A.S.M.E. in San Francisco will be the presentation of the fifth Calvin W. Rice Lecture, at the Engineers' Day Banquet on Treasure Island, July 13, by Dr. Rodolfo E. Ballester, engineer and director of the Argentine Bureau of Irrigation, S. A. In his lecture, entitled "Economical and Technical Aspects of Argentina," this well-known hydraulic engineer will discuss the subject of irrigation and engineering in his native country

RODOLFO E. BALLESTER

and how engineers of the United States may better cooperate with those of South America. The Rice Lectures were instituted by the A.S.M.E. in 1934, for the dual purpose of commemorating the work of Dr. Rice as secretary of the Society for 31 years and with the hope of continuing his development of friendly relations not only between the engineers of the Americas, but also between engineers and engineering organization throughout the world.

Dr. Ballester was born in San Martin, in 1887, and graduated with honors from Buenos Aires University as a civil engineer, in 1912. He was assistant engineer on the construction of the Neuquen Dam works, and chief engineer of the Rio Negro irrigation project, which was completed in 1927. Since then he has been connected with the Argentine Bureau of Irrigation, first as inspecting engineer, then as vice-director, and now as director, in charge of construction and management of irrigation, drainage, and flood-control works carried on by the Republic of Argentina. He is also professor of applied hydraulics at Buenos Aires University.

Engineers of the United States and other countries of the world are acquainted with Dr. Ballester through his work as vice-chairman of the Argentine Committee of the World Power Conference, from 1930 to 1937, and as the official delegate of the Argentine Government to the Third World Power Conference and Second Congress of Large Dams, in Washington, D. C., in 1936. He is a member of the National Council of Meteorology, Geophysics, and Hydrology, and of the Centro Argentino de Ingeniero, of which he was vice-president from 1937 to 1938.

MOCCASIN CREEK POWER HOUSE, 140 MILES FROM SAN FRANCISCO, ONE OF THE PLANTS THAT MAY BE VISITED DURING THE A.S.M.E. SEMI-ANNUAL MEETING

(Static head, 1316 ft; average head, 1250 ft; four 28,000-hp water wheels connected to four 20,000-kw generators.)

A.S.M.E.-S.P.E.E. Luncheon Planned for Wednesday, July 12

Because of the great success of the joint A.S.M.E.-S.P.E.E. luncheon at the Spring Meeting in New Orleans, Feb., 1939, a similar affair is being arranged for Wednesday noon, July 12, during the 1939 A.S.M.E. Semi-Annual Meeting in San Francisco. In charge of arrangements for this luncheon is Prof. A. B. Domonoske, of Stanford University, who expects an attendance of more than 100 engineering educators and engineers. Presiding will be Prof. Jiles W. Haney, chairman of the mechanical-engineering division of the S.P.E.E. Prof. A. G. Christie, President of the A.S.M.E., will be the guest of honor and chief speaker.

Visiting Engineers Will Have Wide Choice in Plant Trips

Although only one regularly scheduled plant trip will take place during the 1939 A.S.M.E. Semi-Annual Meeting, and this to the Columbia Steel Company's plant at Pittsburg, California, trips to Stanford, California, and Santa Clara Universities, as well as trips to steam and hydroelectric plants, manufacturing establishments, and process industries will be available to visiting members and guests. Arrangements will be made at the time requests are received and transportation will be furnished at a reasonable cost.

The trip to the Columbia Steel Company will start from the Fairmont Hotel at 2:00 p.m. on July 12, crossing the San Francisco Bay Bridge to the East Shore Highway, skirting the San Francisco-San Pablo and Suisun Bays, passing en route the oil refineries, Carquinez Bridge, and Crockett Sugar Refinery plant, and arriving at the steel plant at approximately 4:00 p.m. The plant-inspection tour will take three hours and, in this time, one will have an

Californians, Inc.

CHINATOWN, SAN FRANCISCO

(The world's largest Chinese section outside of the Orient.)

opportunity to inspect a complete steel plant in all its phases. At 7:00 p.m. dinner will be served at the Los Medanos Hotel. After dinner, the party will return from Pittsburg by way of Concord, Walnut Creek, and Low Level Tunnel, crossing the San Francisco Bay Bridge to the Fairmont Hotel. The distance covered will be approximately 95 miles through some of the most beautiful California scenery.

Always of interest is a visit to a naval ship. Members and guests will have an opportunity to inspect one or more of the vessels of the Pacific Fleet of the U. S. Navy which will be anchored in San Francisco Bay during the A.S.M.E. meeting.

Tea and Trip to Chinatown Planned by Women's Committee

During the 1939 A.S.M.E. Semi-Annual Meeting, the womens Committee, Mrs. Oliver B. Lyman, chairman, has arranged to hold a tea at the Fairmont Hotel in the South Laurel Court from 4:30 to 6:00 p.m., Monday, July 10, to which all of the women are cordially invited. They may bring their husbands if they wish. This will also be in the nature of an informal reception to give the out-of-town guests an opportunity to meet the wives of the San Francisco members.

On Tuesday afternoon, a special trip is being arranged to Chinatown for the ladies and their escorts. During the tour, the party will stop off at a Chinese tearoom. Special trips to other points of interest in and about San Francisco, as well as guest cards to women's clubs, will be arranged for those who are interested.

Actions of A.S.M.E. Executive Committee

AT A meeting of the Executive Committee of the Council of The American Society of Mechanical Engineers, held in the rooms of the Society on May 19, 1939, there were present A. G. Christie, president of the Society, Kenneth H. Condit, Harte Cooke, and J. W. Parker, members of the committee; K. M. Irwin (Finance Committee), J. N. Landis (Committee on Local Sections), and C. E. Davies, secretary. The following actions were of general interest:

Appointments

R. L. Sackett was appointed to fill the unexpired term of C. F. Hirshfeld, deceased, on the Engineers' Council for Professional Development to October, 1939, and thereafter to serve a three-year term expiring October, 1942.

Owing to the request of K. W. Jappe that he be relieved of his position as representative of the Finance Committee on the Committee on Aims and Objectives, Alfred I. Iddles, chairman of the latter committee and Council representative of the Finance Committee was designated to fill the remainder of Mr. Jappe's term.

Other appointments reported for record were:

Power Test Code Committee No. 13 on Refrigerating Systems, B. H. Jennings and H. A. Feldbush.

Forest Committee, National Fire Protection Association, C. B. White.

Daniel Guggenheim Medal Board, Alexander Klemin (three years).

Fiftieth Anniversary, Chicago, May 31, June 1 and 2, of the Heating, Piping, and Air Conditioning Contractors National Association, L. W. Wallace.

Calvin W. Rice Lecturer, 1939 Semi-Annual Meeting, July, 1939, Rodolfo E. Ballester, director of irrigation department of Argentina, Buenos Aires, Argentina.

Coming Meetings

Upon recommendation of the Committee on Meetings and Program, approval was voted of Spokane, Wash., September, 1940, and Atlanta, Ga., June, 1941, as meeting places for the 1940 Fall Meeting and the 1941 Semi-Annual Meeting, respectively.

It was also voted, upon recommendation of the Committee on Meetings and Program, to cooperate with Cornell University in the celebration of the centenary of the birth of Robert Henry Thurston, first president of the Society, on October 25, 1939, and to designate J. W. Parker A.S.M.E. representative on the program committee for this event.

Upon recommendation of the Hydraulic Division and with the concurrence of the Committee on Professional Divisions it was voted to authorize participation by the Hydraulic Division in the International Hydrologic Union Meetings, Washington, D. C., September, 1939.

Registration in Professional Divisions

In 1927 when the Transactions were issued in a number of sections sponsored by the various professional divisions, every member of the Society was permitted to register in three divisions and to receive the publications of the divisions he elected. In 1934, as an economy measure, the number of choices per member was limited to two. In the fall of 1934, the several divisional sections of Transactions were combined in a single publication, issued monthly and sent to all members of the Society registered in the divisions. Registration in divisions lost its significance when this change was made in so far as distribution of sections of Transactions was concerned, and hence members were permitted to register in any number of divisions for the purpose of receiving special announcements. In order to clarify the existing situation, upon recommendation of the Committee on Professional Divisions, it was voted to record in the Society office only the first three choices of a member's interest in the various professional divisions.

Power Test Code Approved

Record was made of the approval by the Council for printing and adoption as standard practice of the Society of a test code for displacement compressors, vacuum pumps, and blowers.

Previous Appointments

At a meeting of the Executive Committee of The American Society of Mechanical Engineers, held at the Society headquarters in New York on April 21, 1939, the following appointments were reported for record:

Professional Conduct, V. E. Alden (to December, 1939); executive committee of the Aeronautic Division as junior adviser, Herbert Kunen; Standardization Committee sectional committees; Approval and Installation Requirements for Gas-Burning Appliances, O. F. Campbell; Specifications for Cast-Iron Pipe and Special Castings (A21), L. R. Howson; Plain and Lock Washers (B27), E. M. Whiting; Power Test Codes Committee No. 17, Internal Combustion Engines, O. D. Treiber; Hoover Medal Board of Award, W. L. Batt (6 years); National Research Council, Division of Industrial Research, W. L. Batt; American Institute of Physics executive committee of Temperature Measurement Symposium, H. F. Mullikin; E.C.P.D. delegatory committee for region IV, F. L. Wilkinson, Jr.; N.A.C.A. aeronautics laboratories annual inspection, Langley Field, May 2, Alexander Klemin; National District Heating Association annual convention, June 26, Alfred Iddles; 50th anniversary celebration, June 4 and 5, University of New Mexico, J. R. Van Dyke.

A.S.M.E. to Cooperate With Cornell in Thurston Anniversary

THE Executive Committee of the A.S.M.E. Council at a recent meeting approved the participation and cooperation of the Society with Cornell University in the celebration on October 25 of the one-hundredth birthday anniversary of Dr. Robert Henry Thurston, one of the original founders and first president of the A.S.M.E. James W. Parker, vice-president, A.S.M.E., and chief engineer of The Detroit Edison Co., was designated by Council as the Society's representative for this event.

Applied Mechanics Division of A.S.M.E. Holds National Meeting in New York

Members Are Guests of Columbia University, June 14–15, E. Fermi, Nobel Prize Winner, Guest Speaker at Dinner

DUPLICATING the success of previous meetings at Purdue, Yale, Michigan, Carnegie, and Cornell Universities, the sixth National Meeting of the Applied Mechanics Division of the A.S.M.E., attended by more than 100, took place in New York, June 14–15, at the invitation of Columbia University, which acted as host for the occasion. Cooperating in the arrangements was the Metropolitan Section of the Society. Living accommodations for the men were provided at no charge by the University in John Jay Hall, while the women in attendance were housed in Johnson Hall.

The four technical sessions, which were held at the Pupin Physics Laboratory, covered the subjects of elasticity, plasticity, lubrication, and dynamics. The 13 papers, together with their discussions will be published in full in the forthcoming issues of *The Journal of Applied Mechanics*. Chairmen of the sessions were R. E. Peterson, A. Nádai, G. B. Karelitz, and J. Ormondroyd.

Nontechnical Events

At the dinner held in the Faculty House on Wednesday evening, June 14, R. Eksergian, chairman of the Division, acted as toastmaster. Dean G. B. Pegram, representing the University, extended a hospitable welcome to those present. The toastmaster then introduced the guest speaker of the evening, Enrico Fermi, winner of the 1938 Nobel Prize in physics for his work on low-speed neutrons, who talked on the "Splitting of the Uranium Nucleus," and told of the work done so far with the Columbia University cyclotron in an attempt to discover the secret of the atom and its possible use for energy.

On Thursday afternoon at 4 p.m., a meeting of the Executive Committee of the Division was held. Chairman Eksergian presided. After welcoming Prof. A. G. Christie, President of the A.S.M.E., the Committee discussed the papers and sessions for the 1939 Annual Meeting of the A.S.M.E. in Philadelphia in December, and considered plans for sessions at the four National Meetings of the Society in 1940.

Thursday evening, the whole party went to the World's Fair where an informal dinner was held in the beautiful Casino of Nations. This was followed by visits to some of the industrial exhibits and to the pyrotechnic display on the Lagoon of the Nations.

A Women's Committee, composed of Mrs. G. B. Pegram, Mrs. M. A. Biot, Mrs. J. M. Garrelts, Mrs. C. F. Kayan, Mrs. M. K. Newman, and Mrs. E. N. Kenyon, made arrangements for the visitors to do some shopping and to see some of the museums and sights of the city.

Cyclotron and Books Shown

An interesting feature of the meeting was the inspection of the cyclotron, the workings of which were demonstrated to the visiting scientists and engineers. Also shown was an exhibit of rare old books dealing with applied mechanics, some dating from as far back as the sixteenth century. This was made possibles through the cooperation of the University's Library.

Acknowledgments

The great success of the meeting, which was attended by more than 100 members, guests, and ladies, was due to the hospitality of Columbia University and the efforts of Dean G. B. Pegram, G. B. Karelitz, C. F. Kayan, R. D. Mindlin, M. A. Biot, D. C. Drucker, J. M. Garrelts, I. E. Madsen, M. K. Newman, and V. J. Skoglund, who were assisted by C. H. Dalway of the Metropolitan Section, A.S.M.E., the Executive Committee of the Applied Mechanics Division, consisting of R. Eksergian, J. P. Den Hartog, H. L. Dryden, J. H. Keenan, and B. M. Woods; and headquarters staff.

Objectives Formulated by A.S.M.E. Management Division

OBJECTIVES of a definite policy of the Management Division of the A.S.M.E. were formulated at the meeting of its executive committee on May 25, and endorsed. However, detailed discussion of the policy was deferred so that members may send in their comments.

The policy reads as follows:

"The A.S.M.E. has a traditional place in the management field in that it provides opportunity for the engineering approach to management problems and provides a clearing house of peculiar value to those involved in the administration of engineering and industrial problems. The purpose of the Management Division is to develop by the engineering approach, through meetings, papers, committee reports, and other means, the management problems of industrial organization, including utilities, transportation, and communication, but omitting finance, government, and retailing, in the following ways: Philosophy of administration and management; administration and management policies; production control; engineering and design; research and development; plant and equipment; sales and distribution as related to the other functions; budgeting and cost accounting; industrial relations; purchasing stores and inventory control; quality control; organization for control; organization for operation; maintenance of plant machinery and equipment; and pricing.

"As sample policies for discussion, the following are suggested: Low price–large production versus high price–small production; and change from empiricism to facts, from words to figures, from qualitative thinking as illustrated in statistical inspection, and in statistical analysis of time-study observations."

Regulation Group Holds Dinner on April 3

A SMALL group of engineers, including some members of the A.S.M.E. Committee on Industrial Instruments and Regulators, met at dinner on April 13 in New York and later carried on an informal discussion at A.S.M.E. headquarters. The purpose of the meeting was to give Messrs. Ivanoff and Howard, formerly of Geo. Kent, Ltd., of England, an opportunity to compare notes with engineers in this country and particularly with Dr. Minorsky.

Dr. Ivanoff reviewed his papers on the analysis of regulated systems based on Fourier's heat-flow theory for a semi-infinite solid and a harmonic input, and showed that an over-all sensitivity of about 23 was the maximum theoretically possible with a throttling (proportional) regulator, i.e., one in which the heat input increased as the temperature dropped. He also discussed the maximum sensitivities possible for the commoner regulators without hunting and presented some unpublished work on vectorial treatment of lags, using a "latitude-and-departure" method.

Members of the A.S.M.E. committee brought out the fact that Mason's paper made use of the hydraulic analogy for thermal systems and that the physics of such a system required that attenuation be considered, much as Ivanoff had done, and the introduction of distributed capacities and resistances for such analogy be usefully accurate. It was noted that Mason's analysis was well suited for the analysis of liquid-level regulation and for processes where attenuation introduced no special difficulties, and that the German work, recently digested and translated for the committee by Spitzglass and Zucrow, laid particular

A.S.M.E. Officers Nominated for Coming Year

Members of the A.S.M.E. Nominating Committee for 1939, W. L. Edel, chairman, T. Baumeister, Jr., B. F. Rogers, B. R. Van Leer, F. C. Hockema, F. J. Holzbaur, and E. B. Parker have nominated as directors of the Society for 1939 the following:

OFFICE	NOMINEE
President	Warren H. McBryde
Vice-Presidents	Kenneth H. Condit
	K. M. Irwin
	J. C. Hunsaker
	Francis Hodgkinson
Managers	J. W. Eshelman
	G. T. Shoemaker
	Linn Helander

Biographical sketches of the candidates for office will be published in the August issue of MECHANICAL ENGINEERING.

emphasis upon sudden changes of the "load" and the resultant performance of regulated systems of different types, especially when their "self-regulation" was considered.

Dr. Minorsky presented a treatment parallel to that of Ivanoff's in which regulated systems were considered from the standpoint of mechanics (as oscillating dynamic systems involving the equivalents of masses, springs, and damping) and making use of differential equations (much as in Mitereff's paper) and combining the like terms of the regulator and the system (as noted in Mason's paper). As evidence that such treatment is well accepted, one of the differential equations was recognized by a patent attorney present as that pertaining to a well-known air-operated "reset-type" regulator.

It was also brought out that hydraulic regulation in the field of press design involved mainly sequence operation with control of accelerations, velocity, and deceleration, frequently of heavy masses.

The discussion closed with a consideration of a special type of kinematic reset in which the departure was related with the result and movement and rate of movement of the controller, instead of the movement of the controller corresponding to the departure and rate of departure, as in conventional regulators. It was generally agreed that this feature did not simplify the solution of the differential equations.

Taken altogether, it appeared that the regulators themselves were the only things in common for the various types of systems to be regulated and that the different systems called for different kinds of analyses.

Among those present, in addition to Messrs. A. Ivanoff and G. P. E. Howard, were E. S. Smith, who acted as chairman, and Messrs. J. C. Peters, E. W. Cannon, A. V. Smith, and Dr. Nicolai Minorsky.

Fourth Annual A.S.M.E. Photographic Exhibit Philadelphia, Dec., 1939

MEMBERS of the Society and their friends are invited to submit technical and nontechnical photographs for showing at the Fourth Annual A.S.M.E. Photographic Exhibit to be held during the 1939 Annual Meeting of the Society in Philadelphia, Dec. 4–8, 1939. Prints mounted on 16 × 20-in. light-colored cards should be sent, on or before Nov. 30, 1939, to the A.S.M.E. Photo Exhibit Committee, The Engineers Club, 1317 Spruce Street, Philadelphia, Pa., together with an entry fee of $1 to cover return postage, insurance, wrapping, etc. This year, MECHANICAL ENGINEERING will award cash prizes of $5, $3, and 2, and honorable-mention citations for all photographs selected for reproduction on the cover and in the editorial pages of the Society's journal. Official entry forms may be secured from the Committee.

American Institute of Physics Organizes Temperature Symposium, Nov. 2–4

IN ORGANIZING a symposium on the measurement and control of temperature in science and industry the American Institute of Physics commemorates the twentieth anniversary of a well-known "Symposium on Pyrometry," the published papers of which are still valuable as references. At the time of the previous symposium the subject was well known only in the "high-temperature" industries, such as steel and ceramics, and in relatively few laboratories. Since then its importance has grown considerably. An international temperature scale has been established, many universities have broadened their curricula to improve training in temperature measurement and heat transfer, new industries dependent on temperature measurement and control have sprung up, measuring and controlling instruments of greatly improved design and accuracy have become available, engineering societies have established committees especially concerned with the subject, and progress generally has been so marked and diverse that the usefulness of such a symposium at this time is readily recognized.

In view of these developments the Institute has planned a symposium with the following purposes in view: (1) Coordination of the treatment of the subject of temperature in the several branches of science and engineering; (2) review of principles and recording of recent work; (3) accumulation of contributions for a comprehensive text to be published after the symposium; (4) emphasis on the importance of temperature as a branch of physics; and (5) improvement of technical curricula through making available up-to-date information.

Symposium to Be Held Nov. 2–4, 1939

All interested persons active in science or engineering are cordially invited to contribute papers to the symposium. Also, any person who is interested in hearing some or all of the papers is welcome and invited to attend.

The symposium will be held in New York, N. Y., Nov. 2–4, 1939. There will be a special dinner on the evening of November 3.

An extensive printed program, containing titles and full abstracts of all papers to be presented, will be ready for distribution in October. This complete program will be furnished to all who register for the symposium. A registration fee of one dollar will be charged to defray printing and mailing costs. Opportunity to register will be provided at the meeting. Anyone who wishes to register *in advance* and receive the program *as soon as it is printed* may do so by sending his name, address, and fee of one dollar to the Temperature Symposium Committee, American Institute of Physics, 175 Fifth Avenue, New York, N. Y.

Instructions for Contributors

Those desiring to contribute papers to the symposium must send titles and abstracts thereof to the Institute office not later than September 15 to permit arrangement and printing of the program. Complete manuscripts are desired by October 25 but will be accepted for publication up to December 31, 1939.

Special contributions in the form of bibliographies, compendiums, and tables, may be accepted for publication without oral presentation, in which case they will appear on the program for presentation "by title."

It is planned to publish the proceedings of the symposium in 1940. Every effort will be made to make the publication complete and to include discussions as well as papers.

Contributions dealing with temperature measurement in the field of general engineering should be sent to H. F. Mullikin, chairman, General Engineering Committee, The Babcock & Wilcox Company, 19 Rector St., New York, N. Y. Mr. Mullikin was appointed as an A.S.M.E. representative to serve on the Temperature Measurement Symposium Committee.

News of Woman's Auxiliary to A.S.M.E.

THE REGULAR May meeting of the Woman's Auxiliary to the A.S.M.E. was held on the afternoon of May 11 at the Engineering Societies Building when a resolution to form a Metropolitan Section was debated and carried unanimously.

A special meeting of the Auxiliary was held June 8 at the Engineering Woman's Club to arrange the women's program for the Fall Meeting in New York, September 4 to 9. Details of this program may be found on pages 563 and 564 of this issue.

It is hoped that all of the women who are willing to assist and who will be in the city on August 10 and August 31 will meet with the Auxiliary at 2 p.m. in the Engineering Woman's Club so that final arrangements can be completed for the Fall Meeting.

Mrs. George W. Farny, president of the Auxiliary, entertained June 3 at her home, Craftsman Farms, with an interesting musicale and a delightful tea.

It is with great regret that the Auxiliary learned of the death of Mrs. Willis H. Carrier on June 3 at Syracuse, N. Y. Mrs. Carrier was one of the first members of the Auxiliary and was especially interested in the Educational Committee, being its chairman in 1928. She was hostess to the Auxiliary on several occasions at her former home in Essex Fells, N. J. Her warm personality and active interest in our organization will be greatly missed. In Syracuse she was one of the leaders in forming a local section and reported favorable interest in the plan at the Annual Meeting last December in New York.—BURTIE HAAR, Chairman, Publicity Committee.

Engineering Societies Library Closes at 5 p.m. in Summer

BEGINNING on June 12 and continuing through Sept. 9, the Engineering Societies Library, 29 West 39th Street, New York City, will be open weekdays from 10 a.m. to 5 p.m.

Outline of Tentative Program

Headquarters for the Civil Group Will Be at Columbia University, While Headquarters for the Mechanical Group Will Be the Engineering Societies Building

	Civil Group	*Mechanical Group*
MONDAY September 4		
Morning	Sight-seeing trip around New York City	Sight-seeing trip and visit to Empire State Building
Luncheon	Rainbow Room, Rockefeller Center	Pennsylvania Hotel
Afternoon	Opening Session at Engineering Societies Building Reception and Tea Inspection of Library and Offices Unveiling of Rice Memorial	
Evening	Reception, Buffet Supper, Dancing Faculty Club, Columbia University	Visit to Radio City Dinner Broadcast
TUESDAY September 5		
Morning	General Meeting	Marine Session
Afternoon	Boat Excursion about New York Harbor and thence to the World's Fair by boat (Buffet Luncheon on boat)	
Evening	At the World's Fair	
WEDNESDAY September 6		
Morning	Sessions on Construction Methods, Highways, Sanitation and Water Supply	Railroad Session
Luncheon	At Faculty Club, Columbia University or near-by restaurants as desired	Pennsylvania Hotel
Afternoon	Sessions on Soil Mechanics, Landing Fields, City Planning, and Parkways	Railroad Exhibits at World's Fair
Evening	Banquet and Dance, Hotel Waldorf Astoria	
THURSDAY September 7		
Morning	Sessions on Soil Mechanics, Structural Design, Use of Electricity, etc.	Highway Session
Luncheon	At Faculty Club, Columbia University or near-by restaurants as desired	Pennsylvania Hotel
Afternoon	Inspection trips, Motor Exhibits at World's Fair	
Evening	Program at McMillin Theater 75th Anniversary, Columbia University Engineering School	
FRIDAY September 8		
Morning		Transatlantic Airplane Session
	Closing Session at World's Fair	
Luncheon	At World's Fair or as desired	
Afternoon	Visit to North Beach Airport or World's Fair, as desired	
Evening	As desired	
SATURDAY September 9		
	Departure of British Civil Group for Washington, D. C.	Departure of British Mechanical Group for Niagara Falls

A.S.M.E. Fall Meeting, New York, Sept. 4-8

British Engineers to Join With Americans in Week of Varied Activities

PLANS ARE rapidly being perfected for the 1939 National Fall Meeting of The American Society of Mechanical Engineers in New York during the week of Labor Day, in which The Institution of Mechanical Engineers of Great Britain is to join. During the same week The Institution of Civil Engineers and The Engineering Institute of Canada are also meeting in New York with The American Society of Civil Engineers. The week's program of both the civil and mechanical groups is therefore being jointly arranged so that members of any one of the societies may have complete opportunity to participate in any of the events of the meeting that they wish. The outline program (appearing on this page) shows what has been planned for the civil and the mechanical groups and the women of both groups.

The technical program of the I.M.E.–A.S.M.E. with the names of authors of the papers to be presented appeared in the June issue of MECHANICAL ENGINEERING. It will consist of four sessions devoted to the mechanical problems of modern transportation. One session each will be given over to marine, lightweight high-speed trains, highway, and transatlantic airplane transport.

Following the meetings in New York the British engineers will spend two weeks visiting points in Canada and the United States. In the places to be visited in Canada the branches of The Engineering Institute of Canada are extending a most hearty welcome. The events at Niagara Falls, Ontario, Hamilton, and Toronto have been planned entirely by the members of The Engineering Institute of Canada with the cooperation of the Ontario Section of the A.S.M.E.

At Detroit, the Detroit Section of the A.S.M.E. has taken the leadership in working out the program and in it they will be joined by the Border City Branch of The Engineering Institute of Canada. In a similar manner the sections in Cincinnati, Washington, and Philadelphia are cooperating wholeheartedly to the end that the British visitors will have an opportunity to enjoy not only visits to industrial plants but also to make acquaintances among their mechanical colleagues in this country.

Women's Program

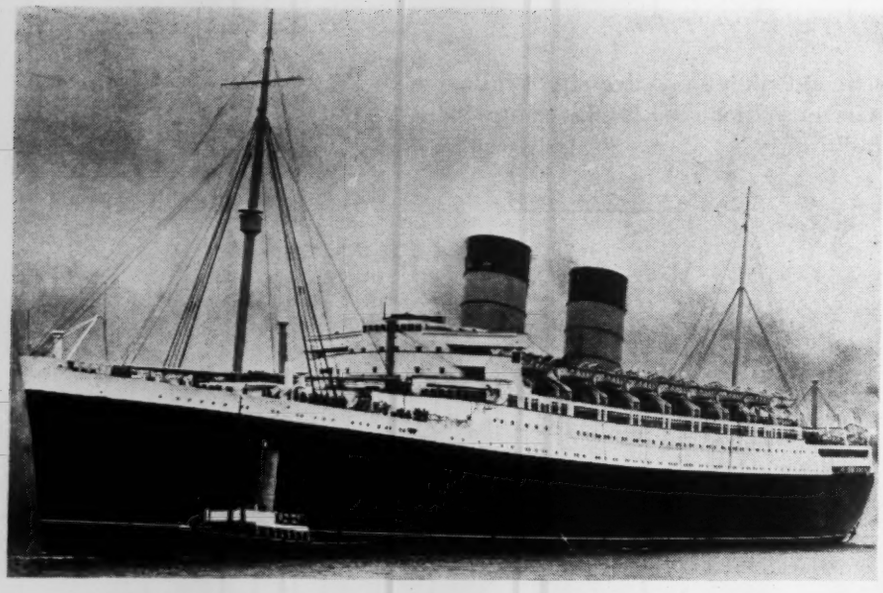
The tentative program for the entertainment of the women is as follows:

Monday, Sept. 4

All day with the men.

Tuesday, September 5

In the morning the women will be escorted to the Museum of the City of New York and the Museum of Natural History. They will



THE NEW 34,000-TON, 772-FT LONG *Mauretania* PRIOR TO HER MAIDEN VOYAGE TO THE UNITED STATES ON JUNE 17

(The new *Mauretania* of the Cunard White Star Line, which is the largest ship ever built in England, left England for her maiden voyage to the United States on June 17. She is 772 ft long, 89½ ft in breadth, registers 34,000 tons, has a displacement of 36,000 tons, and the height from the keel to the top of each of the two funnels is 155 ft. The ship is propelled by single-reduction-geared turbines which obtain the necessary steam from six Yarrow side-fired boilers of the double-floor type. Dust collectors in the funnels prevent soot from falling on the open decks. Two propellers, each weighing 25 tons, are driven through two main gears, that weigh 85 tons apiece and are the largest constructed for any ship, not excepting the *Queen Mary* or the *Queen Elizabeth*.)

have luncheon with the men's group and go with the men on the boat trip and to the Fair.

Wednesday, Sept. 6

A choice of three trips is offered:

(1) Guided shopping tour, followed by luncheon at Women's Republican Club.

(2) Visit to Morgan Library followed by luncheon at Engineering Woman's Club.

(3) Visit to World's Fair—Luncheon at Fair (place to be selected).

The early part of the afternoon is left free. Tea will be served both at Columbia University and at the Pennsylvania Hotel.

Thursday, Sept. 7

All-day trip by bus following Albany Post Road to Bear Mountain Bridge, then to West Point, returning to Bear Mountain Inn for lunch. Drive back through New Jersey to Hoboken for tea at Stevens Institute of Technology as guests of Dr. and Mrs. Harvey N. Davis. Return by way of the Lincoln Tunnel.

Evening. With men at Columbia.

Friday, Sept. 8

All day with the men.

L. W. Wallace Represents A.S.M.E. at 50th Anniversary of H.P.&A.C.

REPRESENTING the A.S.M.E. at the Fiftieth Annual Convention and Fiftieth Anniversary Celebration of the Heating, Piping, and Air Conditioning Contractors National Association in Chicago, Ill., May 31–June 2, was Vice-President L. W. Wallace.

Advisory Committee Formed by Management Division

TWENTY-SIX industrial executives, management engineers, and leaders in management research and education have accepted invitations to serve on the General Committee of the Management Division of the A.S.M.E., according to an announcement by W. H. Kushnick, chairman of the Division's Executive Committee. The broad background of experience, and knowledge of shifting trends in management represented by this advisory group will aid the committee in formulating a program of activities best fitted to the needs of members of the Division.

Industrial Executives

Industrial executives who will serve on the committee include L. A. Appley, educational director, Socony-Vacuum Oil Co.; W. L. Batt, president, SKF Industries; F. B. Bell, president, Edgewater Steel Co.; H. V. Coes, manager, industrial department, Ford, Bacon & Davis; N. E. Elsas, president, Fulton Bag & Cotton Mills; R. E. Flanders, president, Jones & Lamson Machine Co.; W. D. Fuller, president, The Curtis Publishing Co.; Lee Galloway, vice-president, Ronald Press Co.; L. W. Wallace, director of research, Crane Co.; W. S. Hosford, vice-president, Western Electric Co.; and D. L. Royer, chief engineer, Ocean Accident & Casualty Co.

Management and Research Authorities

Management engineers and research authorities from engineering schools include L. P. Alford and D. B. Porter, New York University; P. M. Barnes, University of Iowa; C. W. Beese and L. M. Gilbreth, Purdue University; K. H. Condit, National Industrial Conference Board; P. E. Holden, Stanford University; D. S. Kimball, Cornell University; T. S. McEwan, Stevenson, Jordan, Harrison; W. Rautenstrauch, Columbia University; F. E. Raymond and E. H. Schell, Massachusetts Institute of Technology; J. W. Roe and E. D. Smith, Yale University; and John Younger, The Ohio State University.

Mr. Kushnick also announced the appointment of C. S. Gotwalls, SKF Industries, as local section representative for Philadelphia; and H. J. McIntire, University of Washington, as local section representative for the Western Washington Section.

Gage Laboratory Started at Carnegie Tech

THE Ordnance Department of the United States Army established a gage laboratory at the Carnegie Institute of Technology in April, thus considerably increasing facilities for research and industry in the Pittsburgh district. The primary purpose of the laboratory is to make available standard measurements of the greatest accuracy for the machines which produce Army equipment. More than $20,000 worth of delicate precision instruments, accurate to the hundred thousandth and millionth of an inch, will be installed in a laboratory in Industries Hall at Carnegie Tech.

The laboratory will be operated under the general supervision of Dr. Webster N. Jones, director of the College of Engineering, and Major C. H. Morgan, executive officer of the Pittsburgh Ordnance District. Prof. C. C. Leeds, member A.S.M.E., will be in charge of the laboratory.

The equipment makes possible measurements within two millionths of an inch by means of the Van Keuren light-wave equipment used to determine the wear on Johansson precision-measuring blocks or diameters of ball bearings and similar measurements where great precision is essential. Another piece of equipment measures length to the hundred thousandth of an inch. Other apparatus includes a screw-thread-testing machine, comparators, microscopes, micrometers, surface plates, straightedges, levels, parallels, and squares. All precision equipment has been calibrated at the U. S. Bureau of Standards, and the tabulated calibrations are part of the laboratory records.

H. J. Brown Made President of Engineering Societies of New England

NEWLY elected officers of the Engineering Societies of New England, Inc., who took up their duties on June 1 for the ensuing year are: president, H. J. Brown, member A.S.M.E.; vice-presidents, L. P. Jackson and J. Peterson; treasurer, H. C. Hamilton; secretary, A. Haertlein; and members at large of the executive committee, J. Holt, member A.S.M.E., and R. M. Hudson, member A.S.M.E.

A.S.T.M. to Change Its Method of Publishing Standards

IMPORTANT modifications are to be made, according to an announcement from the American Society for Testing Materials, in the methods of publishing the Society's standard specifications and tests. These changes are to become effective November, 1939. The major change is to combine the Book of Standards (issued triennially) and the Book of Tentative Standards (issued annually). These changes which also embody numerous advantages are necessary because of the great growth of A.S.T.M. standardization work.

All of the 870 A.S.T.M. standards are in widespread use in many branches of industry and commerce. Each is available, and will continue to be in separate pamphlet form, and the standards have been issued in triennially published books of standards with an annual volume giving the so-called tentative standards and tests.

The new method of publication will be to issue the standards and tentative standards collectively in one triennial publication, divided into three parts: Part I, Metals; Part II, Non-Metallic Materials—Constructional; and Part III, Non-Metallic Materials—General. Publication of new and revised tentative standards in the annual Proceedings, Part I, will be discontinued; the Proceedings including both committee reports and papers (about 1300 pages double-column format) will be bound in one volume. The publication of the annual Book of Tentative Standards will be discontinued entirely. (The November, 1938, edition is thus the last one to be issued.)

In the two years between triennial publication of the new Book, Supplements to each of the three parts will be issued, containing revisions and new or revised standards and tentative standards for that year. Since these books will be appreciably larger than the present supplements and will have permanent reference value, they will be bound in cloth. The volume on Methods of Chemical Analysis of Metals published in 1936 will be continued as a separate publication.

Further details of the publication plan can be obtained from the A.S.T.M., 260 S. Broad Street, Philadelphia, Pa., including the sales prices which have been established for the new Book of Standards, 1940–1941 Supplements, and the annual Proceedings. A.S.M.E. members may make purchases directly through their own Society's Publications-Sales Department, 29 West 39th Street, New York City.

Californians, Inc.

SAN FRANCISCO'S 26 MILLION DOLLAR CIVIC CENTER

A.S.M.E. Calendar

of Coming Meetings

July 10–15, 1939
Semi-Annual Meeting
San Francisco, Calif.

September 4–8, 1939
Fall Meeting
New York, N. Y.

October 5–7, 1939
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions.
Columbus, Ohio

October 5, 1939
Machine Shop Practice Division to hold "A.S.M.E. Day" at Machine Tool Congress, Cleveland, Ohio

October 12–13, 1939
Wood Industries Division
Boston, Mass.

November 2–4, 1939
Joint Meeting with American Institute of Physics in a Symposium on Temperature Measurement, New York, N. Y.

December 4–8, 1939
Annual Meeting
Philadelphia, Pa.

(For coming meetings of other organizations see page 18 of the advertising section of this issue)

Battery-Charging Standards Revised

A NEW set of battery-charging standards has recently been adopted by the Industrial Truck Statistical Association, 208 S. La Salle St., Chicago, Ill., which comprises all the leading producers of electric industrial trucks, batteries, and battery-charging equipment. The scope of these new standards is ample to cover the whole range of installations from that of the first trial truck, adopted by a given industry, to a coordinate fleet of these efficient materials-handling tools.

A.S.M.E. Members Invited by Agricultural Engineers

MEMBERS of the A.S.M.E. are invited to participate in the Pacific Coast Meeting of the American Society of Agricultural Engineers at the World's Fair of the West, San Francisco, July 25. Details of the meeting may be secured from Prof. J. E. Christiansen, University of California, Davis, Cal.

American Engineering Council

Presents

The News From Washington and Elsewhere

Congress Studies Methods of Aiding Business Expansion

GOVERNMENT efforts to stimulate economic recovery are currently concentrated on ways and means of encouraging the spending of private capital in the so-called heavy industries, in which construction plays a prominent part. A number of plans are under consideration, of which the farthest advanced is embodied in a bill (S.2343) introduced by Senator James M. Mead of New York, now the subject of hearings before the Senate Committee on Banking and Currency. This provides for the federal guarantee, through the Reconstruction Finance Corporation, of 90 per cent of the principal of loans made to private industry in amounts ranging from $25,000 to $1,000,000. Alternative plans that have been advanced include the making of such loans through the Federal Reserve system and through several varieties of new banking institutions to be set up under federal control.

The crux of the problem seems to be the provision of long-term capital credit for small and medium-sized business concerns. Ample

short-term credit is available to all businesses through the present banking system, and the larger industrial organizations have no difficulty in raising capital funds. But the normal businessman who wishes to borrow money for a period long enough to finance the expansion of his business has no place to turn. If he could be given access to a source of such credit it is felt that the result would be immediate stimulation of the construction and other producer-goods industries.

This situation is analyzed in a memorandum presented to the Temporary National Economic Committee by Adolf A. Berle, Jr., assistant secretary of state, which deserves careful study by any person interested. Briefly, Mr. Berle finds that, for a number of reasons, the capital markets have been virtually closed since 1931, thus forcing the government to take up the slack by greatly expanding public works. The result has been the expansion of governmental activity into many new fields, a trend that must continue unless some means can be found to restore the volume of private spending. To encourage this he proposes a system of capital-credit banks which will "create" long-term credit in a manner similar to that used by commercial banks to expand and contract short-term credit facilities. Such an institution would serve as a reservoir for investment funds to be drawn upon both by private industry and by government to finance the volume of construction needed to maintain economic equilibrium. It would be a nonprofit organization under governmental or quasi-governmental control, and subject to controls sufficient to avert obvious dangers such as inflation or the accumulation of too extensive governmental management in industry.

Behind the present interest in heavy industry is the unpalatable fact that construction has never recovered to any considerable extent from the slump into which it dropped in the early 1930's. From a peak annual volume of, in round numbers, 12 billion dollars, the value of all U. S. construction dropped to lows, for three successive years, of about three billions, and has since recovered only about half of the lost ground. Meanwhile the proportion of public to private expenditure has jumped from a predepression one third to approximately two thirds of the total volume for each year.

Public-works construction, comprising roads, parks, bridges, buildings, and other facilities, produces but a temporary stimulus to employment, since once the project is completed little labor is required in operation. Private construction, on the other hand, goes largely for new plants and equipment that provide permanent jobs. Hence the current feeling that it might profit the government more to lose a few billions in the assumption of the bad risks in a much larger volume of private loans than to spend the same amount on a continuation of public-works construction over and above the normal construction budget.

Nor does it necessarily follow that the government will be called upon to assume heavy losses. Much depends, of course, on the methods followed in selecting private loans for insurance but the record of the last few years on federal lending has not been discouraging. A recent survey by the *United States News* discloses that since their establishment the Reconstruction Finance Corporation, Home Owners Loan Corporation, Export-Import Bank, and seven other federal lending organizations have advanced to business organizations, railroads, and governmental subdivisions a total of $10,928,128,626. Of this amount $5,771,615,388 has been repaid and $5,156,513,238 is still outstanding. Interest and other income received has totaled $1,365,466,719, while interest charges paid out have amounted to only $637,379,724, leaving a net profit of $414,300,729 after the deduction of $728,086,995 in operating expenses of the agencies. The figures should be accepted with caution because of the many variations in accounting methods used by the ten agencies, but the general conclusion can hardly be challenged that the government has found it profitable to borrow at exceedingly low interest rates and lend at a somewhat higher figure.

Congress Approves Storage of Strategic Minerals

Expenditure of $100,000,000 over a four-year period for the purchase and storage of strategic minerals as a war reserve has been authorized by Congress. The bill, which received final approval by the Senate June 5, does not designate the minerals to be affected but leaves their determination to the discretion of the Secretaries of War, the Navy, and Interior. It also earmarks $2,000,000 of the total to be allocated to the development of domestic sources of supply of the minerals named or of domestic substitutes for them.

The bill was introduced as a national defense measure on the plea that the national safety requires the accumulation, in this country, of tin, manganese, and a number of other imported minerals essential in the manufacture of munitions that might be shut off in case of war.

Civil Service Seeks Advice From Profession

THE President's Committee on Civil Service Improvement has authorized the appointment of a number of special advisory committees and Gano Dunn, a member of the President's Committee, with the assistance of officers of the National Academy of Sciences, the National Research Council, the American Engineering Council, The American Society of Mechanical Engineers, and other leading engineering and technical societies, has appointed three such committees of five members each—one, covering the fields of mathematical, physical, and biological sciences, called for short, the Science Committee; a second, covering the fields of the general engineering societies consisting of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, which is known as the General Engineering Committee; and a third committee covering the fields of the specialized engineering societies, consisting in part of the American Society of Heating and Ventilating Engineers, the Society of Automotive Engineers, the American Society of Agricultural Engineers, the Illuminating Engineering Society, the American Society of Refrigerating Engineers, and representatives of local and state engineering societies, to be known as the Specialized Engineering Committee. The members of these three committees are as follows:

Science Committee

Dr. Ross G. Harrison, chairman, National Research Council; Dr. John A. Fleming, director, department of terrestrial magnetism, Geophysical Laboratory, Carnegie Institution of Washington; Dr. Lyman J. Briggs, director, Bureau of Standards; Dr. W. C. Mendenhall, director, U. S. Geological Survey; and Dr. Roger Adams, professor of organic chemistry, University of Illinois.

General Engineering Committee

E. P. Goodrich, chairman, consulting engineer, and chairman, Committee on Salaries, A.S.C.E.; Dean R. L. Sackett, chairman, Committee on Merit System of American Engineering Council, and past vice-president, The American Society of Mechanical Engineers; S. D. Kirkpatrick, editor, *Chemical & Metallurgical Engineering;* Prof. W. B. Plank, head of department of mining engineering, Lafayette College; Ovid W. Eshbach, fellow, American Institute of Electrical Engineers, and dean, Institute of Technology, Northwestern University.

Specialized Engineering Committee

J. S. Dodds, chairman, vice-president, American Engineering Council, and chairman, A.E.C. Committee on Economic Status of Engineers; Samuel P. Lyle, president, American Society of Agricultural Engineers, and engineer, Bureau of Agricultural Engineering, U. S. Dept. of Agriculture; Thomas Urdahl, consulting engineer, and chairman, Admissions Committee of the American Society of Heating and Ventilating Engineers; Harold D. King, commissioner, Bureau of Lighthouses, U. S. Department of Commerce; and Henry T. Woolson, executive engineer, Chrysler Corp., and past-president, Society of Automotive Engineers.

The memberships of these committees have been selected with reference to qualifications for formulating valuable opinion on civil-service matters either through present or past employment in the government service, experience with merit systems in private industrial or educational fields, or demonstrated personal interest in and knowledge of the history and present problems of the U. S. Civil Service.

Personnel Changes in S.E.C.

To take the place of former Chairman William O. Douglas, now a member of the Supreme Court, President Roosevelt appointed as member of the Securities and Exchange Commission Leon Henderson, who had been execu-

(*A.S.M.E. News continued on page 568*)

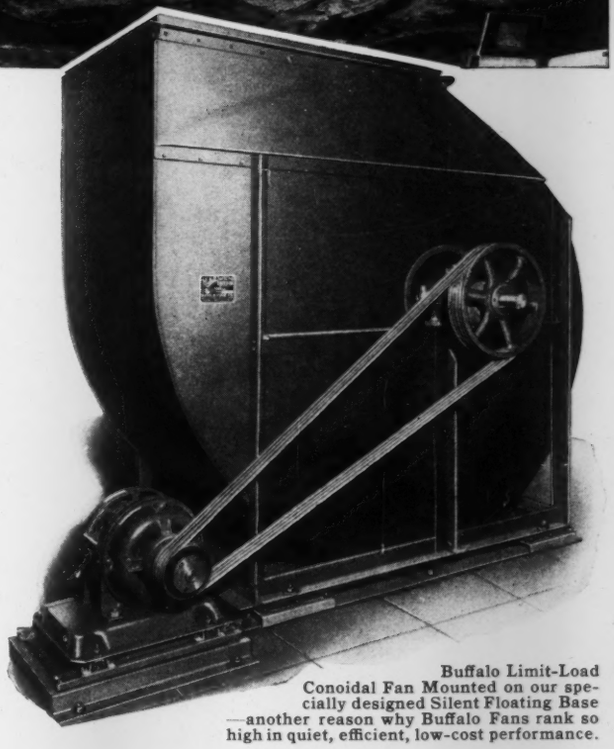
21 Worlds Fair Exhibits are more comfortable ... thanks to "Buffalo" EQUIPMENT

Seventy-one Buffalo Fans and much other Buffalo Equipment such as Air Conditioning Cabinets and Air Washers are helping to make "Weather to Order" in some of the finest exhibits at the New York World's Fair.

This equipment was purchased at regular prices by exhibitors and their engineers who insisted on having equipment they knew to be absolutely dependable

If you have an air handling problem whether it be small volume at high pressure, or large volume at low pressure, or any combination of these, we have the experience and ability to solve your problem efficiently, economically, and to your complete satisfaction.

We solicit your inquiries on the basis that we are well qualified to give you what you need and want.



Buffalo Limit-Load Conoidal Fan Mounted on our specially designed Silent Floating Base —another reason why Buffalo Fans rank so high in quiet, efficient, low-cost performance.

BUFFALO FORGE COMPANY

148 Mortimer Street BUFFALO, N. Y.

Branch Engineering Offices in Principal Cities
Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" **FANS** and AIR CONDITIONING EQUIPMENT for EVERY COMMERCIAL and INDUSTRIAL NEED

tive secretary of the Temporary National Economic Committee. As soon as Mr. Henderson was sworn in, the S.E.C. members, by a vote of 3–2, elected Jerome Frank as their new chairman. Both men are ranked as ardent supporters of President Roosevelt so the conduct of S.E.C. policies will continue along the lines laid out under the chairmanship of Mr. Douglas.

Besides its supervision over stock exchanges and security issues, the S.E.C. is charged with the enforcement of that part of the Public Utilities Holding Company Act dealing with the simplification of corporate structures in the utilities field. Chairman Frank announced, shortly after his election, that the S.E.C. will shortly begin conferences with utility executives for the consideration of reorganization plans submitted last December, and since then under study by the S.E.C. staff.

McClellan Heads Union Electric

Dr. William McClellan, president of American Engineering Council, has resigned as president of the Potomac Electric Power Company, Washington, D. C., to become the head of the Union Electric Company of Missouri, with headquarters in St. Louis. Both companies are subsidiaries of the North American Company.

Reorganization Effective July 1

The two plans for the reorganization of the executive departments of the Federal Government, including the setting up of a new Federal Works Agency in which will be concentrated virtually all present public-works activities of the government, will both become effective July 1, 1939, according to a resolution approved by Congress. Under the terms of the Reorganization Act each of the plans would have gone into effect 60 days after its submission to Congress, on June 19 and July 7, respectively.

After each plan had been sustained by a vote it was decided, in the interests of orderly administration, to adopt a single date for the change over that coincides with the beginning of the federal government's fiscal year.

Practice Orders Awarded by the Army

Bringing to fruition a program long advocated by defense specialists, the War Department has placed the first of a series of educational orders for war materials with leading American manufacturers. The expenditure of $34,500,000 for this purpose was approved by Congress as part of the national defense program.

Several purposes will be accomplished by the plan. In the first place, it will supply needed Army equipment; second, it will school manufacturers in the problems of changing over from peacetime to wartime production; third, it will result in the acquisition by American industry of needed tools and dies that can be kept available for immediate use at any time in the future.

Men and Positions Available

Engineering Societies Employment Service

MEN AVAILABLE[1]

MECHANICAL ENGINEER, 24, R.P.I. graduate. Experience: Student engineer with large company; designed special machinery, hydraulic-control, and test equipment. Desires design or engineering work. Me-314.

RECENT GRADUATE MECHANICAL ENGINEER, young, ambitious, with practical shop experience, willing to travel and willing to consider any opportunity. Preference for drafting, design, or research work. Me-315.

ENGINEER, graduating this June with B.S. M.E., is interested in opening in machine design or industrial-management work. No special location preferred. Me-316.

MANAGEMENT ENGINEER, American, 26 years' experience sales, production, accounting, interested making business surveys for manufacturers for purposes of indicating how sales may be stimulated, costs reduced, and net profits increased. Me-317.

MECHANICAL ENGINEER, 25 years' experience design and construction of mechanical equipment for commercial and industrial buildings, incinerator, sewage disposal, and power plants. Desires position plant engineer or superintendent. Moderate salary. Me-318.

PROJECT ENGINEER, 29, Cornell A.B., M.E.; 5 years' experience in chemical plants; design, construction, estimates, correspondence, project analysis, reports, calculations, supervisory functions. Seeks responsible connection assistant chief engineer process plants. Me-319.

MANAGER OR CHIEF ENGINEER, 20 years' experience; 12½ years as chief engineer leading manufacturer. Plant design, layout, mechanical and electrical equipment, modernization, maintenance, operation, cost reduction, and product improvement. Me-320.

MECHANICAL ENGINEER, 38. Extensive up-to-date experience supervising tool design for stampings, deep drawings, and their routing. Tool and special-machinery design. Creative ability. Desires position leading to executive capacity. Me-321.

MECHANICAL ENGINEER, 48, N. Y. State license. Experienced executive, designer, and chief draftsman on steam and hydro plants, industrial buildings, equipment, and special machinery. Some production control, maintenance and sales. Me-322.

MECHANICAL ENGINEER, 23, Clemson College, 1939. Desires start in training course, engineering concern, or chance to learn power-plant operation. Good health; good personality; will travel; available July. Me-323.

MECHANICAL ENGINEER, 27, single, B.S.M.E. Experience: Locomotive overhaul; assembly, test, turbines, blowers, compressors, pumps, Diesels, centrifugal refrigeration. Desires position assistant operation, maintenance, construction, mining machinery, dredger, power plant. Foreign, U. S. A. Me-324.

[1] All men listed hold some form of A.S.M.E. membership.

MECHANICAL ENGINEER, 23, single, graduate V.P.I., 1939. One year's experience small power plant. Desires work, preferably power or industrial operations, with opportunity for advancement. Available at once. Location, immaterial. Me-325.

MECHANICAL ENGINEER (woman) graduate Rhode Island State College, 1939; 22, single. Member Phi Kappa Phi scholastic society; secretarial training; interested in time and motion study and secretarial work. Me-326.

MECHANICAL ENGINEER, graduate, master's degree, age 25; 2 years' experience in drafting, design, sales, of printing presses, structural steel. Desires to broaden experience in testing and inspection. Me-327.

MECHANICAL ENGINEER; 1933 Illinois graduate; now employed; 10 years' experience, production, plant layout, maintenance, tool and product design, in both small, accurate, high-production, and heavy manufacturing work. Me-328.

GRADUATE ENGINEER, 21; single. Northwestern University graduate. B.S.M.E. Practical experience during summers. Desires engineering development work. Location, Chicago. Me-329.

PRODUCTION ENGINEER, 24, single. Stevens, industrial-engineering major. Shop and design experience in manufacture of office machines and formed metal products. Wish permanent connection. Work in shop to learn business. Me-330.

ASSOCIATE PROFESSOR of mechanical engineering, physics. Harvard, M.I.T., Sc.D. Sigma Xi. Optics, vibration, mathematics, French, German, English, General Science. American, 42, married. Experienced research, manufacturing. Me-331.

POSITIONS AVAILABLE

SALES MANAGER, 35–45. Must have knowledge of merchandising and application of bronze bearings and bushings. Location, Middle West. Y-4243C.

EXECUTIVE REFRACTORIES ENGINEER to take charge of production and direct development for small company manufacturing firebrick and other fire-resisting materials. Location, New Jersey. Y-4244.

PLANT MANAGER, graduate mechanical engineer with production-control experience on heavy equipment. Will help reorganize maintenance and planning departments. Engineer with plant-layout experience for production control, flow of materials, etc., is required. Salary, $60 a week. Location, New York State. Y-4260.

ASSISTANT MASTER MECHANIC, 28–35, with mining-plant equipment experience. Only single man will be considered, as there are no quarters for married men. Salary, $225 a month plus board and lodging. Location, South America. Y-4270.

CHIEF ENGINEER, 35–40, for a nonferrous manufacturing plant. Nonferrous application

(*A.S.M.E. News continued on page 570*)

Smooth flight on the "MAGIC CARPETS"

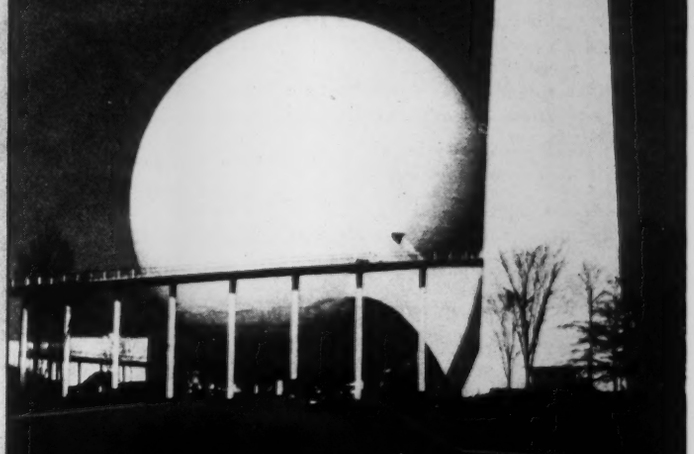
or rotating platforms, in the Perisphere at the New York World's Fair 1939, is assured by

DE LAVAL WORM REDUCTION GEARS

EACH of the two platforms travels on 64 wheels having accurately machined treads and ball bearings, to give the spectators the impression of floating on air. The upper platform, which is 112 ft. 5 in. in diameter to the outer rail, is driven by four 1750 r.p.m. motors through 119.583 ratio gears to make one revolution in 6.28 minutes; and the lower 102 ft. 5 in. diameter platform is similarly driven through four 133.25 ratio gears. Both operate so smoothly that no sound or jar is noticeable.

Write for booklet on

"INDUSTRIAL APPLICATIONS OF WORM GEARS".



DE LAVAL STEAM TURBINE CO., TRENTON, N. J.

1115

experience essential. Location, New England. Y-4272.

SALES ENGINEER, 35–40, whose experience and ability would qualify him to sell copper-alloy parts, used mostly by automotive trade in and about Detroit, Mich. Salary, $3000 a year. Y-4279C.

GENERAL FOREMAN and three shift bosses, ages 30–35, to operate copper converters; also three shift bosses to operate water-jacketed blast furnace. Must be married. Location, foreign. Y-4296.

PLANT SUPERINTENDENT, mechanical engineer, 35–45, to take full charge of small plant manufacturing sheet-steel cabinets and boxes as well as electrical switchboards and panelboards. Must have actual experience in this capacity. Apply by letter giving detailed information and enclosing small photograph. Location, Pennsylvania. Y-4300.

SUPERINTENDENT, not over 45, for plant making sewer pipe, flue lining, drain tile, and wall coping. Experience in manufacture of clay sewer pipe essential. Should be accustomed to Negro labor. Salary to start, $2500 a year. Opportunity. Location, South. Y-4303.

MECHANICAL DESIGNER, 40–45, to take charge of design for production of intricate mechanical-electrical apparatus. Must have held similar position with small or medium-sized company. Location, New York Metropolitan Area. Y-4317.

SUPERINTENDENT of operations. Must be capable of directing operation of automatic machinery, including handling of force of one hundred men, laboratory technicians, etc. Company manufactures optical supplies, camera lenses. Headquarters, New York, N.Y. Y-4323.

MANAGER OR SUPERINTENDENT of large printing plant. Experience is essential. Location, New York, N. Y. Y-4341.

JUNIOR SALES ENGINEER, about 28, graduate of recognized engineering school, who has preferably had a few years' experience operating or servicing equipment. Sales experience desirable, but not essential. After period of training, will become sales or lubrication engineer. Salary to start, $175 a month. Opportunity. Location, New York, N. Y. Y-4348.

MECHANICAL ENGINEER, 25–30, graduate of recognized engineering school, two or three years out, for mechanical development work. Will start on drafting board. Experience in drafting helpful. Opportunity. Salary, $1500–$2000 a year. Location, New Jersey. Y-4351.

MECHANICAL ENGINEER with experience in operation of small metal-stamping and processing plant. Must be thoroughly acquainted with modern production methods, and able to maintain machinery, supervise production, and manage plant employing approximately 20 workers. Salary, $200–$250 a month. Location, Connecticut. Y-4355.

GRADUATE MECHANICAL ENGINEER, 35–45, with at least 5 years' experience as works manager of metal-working plant (metal stamping, deep drawing, and polishing). Experience in pressed-metal field essential, in nonferrous foundry work desirable. Must show successful record of accomplishment as works manager of company now in good standing, and be employed at present. Salary, $7500–$10,000 a year. New England. Y-3608.

GRADUATE MECHANICAL ENGINEER, 35–40, to act as assistant to chief engineer. Must have experience in metal-working plant. Process planning experience essential. Company manufactures blowpipes, regulators, etc. Location, New York, N. Y. Y-3784.

PLANT ENGINEER, mechanical, not over 40, with machine-shop plant experience. Will be in charge of all engineering up to production of product, including maintenance, repair, estimating, and erection of equipment. Must be cooperative. Salary, $300–$400 a month. Location, Pennsylvania. Y-4370.

GRADUATE MECHANICAL ENGINEER, 35–45, with experience in rubber industry. Company will consider research engineer with wide background in all types of plant engineering in any large manufacturing company. Salary, $300–$350 a month. Middle West. Y-4391C.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after July 25, 1939, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references.

Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Reelection; Rt = Reinstatement; Rt & T = Reinstatement and transfer to Member

NEW APPLICATIONS

For Member, Associate, or Junior

BUFORD, EDWIN H., Anniston, Ala. (Rt)
CARPENTER, B. S., Los Angeles, Calif. (Rt & T)
CHENOWETH, G. M., JR., Bloomfield, N. J.
DOUGHTY, FRANKLIN O., St. Joseph, Mo.
FLINN, A. V., Pendleton, Manchester, England
GOLLMER, HUGO C., New York, N. Y.
HALL, COLLIER, Catlettsburg, Ky. (Re)
HARRISON, HERBERT L., Chicago, Ill.
KLINE, CLEMENT L., New Castle, Ind.
KOEHLER, OSCAR E., Greenfield, Mass. (Rt)
KOPETZ, GEORGE E., Mt. Vernon, Ill.
LEE, ROBERT E., Chicago, Ill.
MANGER, C. PHILIP, Baltimore, Md.
MANS, F. J., Curacao, D. W. I.
MARTIN, JOHN L., West Allis, Wis.
MATTICK, NICHOLAS J., Alton, Ill.
MEYER, F. L., Peoria, Ill.
MONTGOMERY, J. E., London, England
RODRIGUEZ, A. U., San Luis Potosi, Mex.
TAYLOR, E. G. T., Toronto, Ont., Canada
TRIMMER, CHARLES A., Madison, S. D.
WAY, STEWART, East Pittsburgh, Pa.
WELLENKAMP, PAUL G., Bound Brook, N. J.

CHANGE OF GRADING

Transfers to Fellow

KULJIAN, HARRY A., Philadelphia, Pa.
WADSWORTH, J. F., Erie, Pa.

Transfers to Member

BASS, RUSSELL B., Waterbury, Conn.
BURRESS, L. F., Gary, Ind.
HURT, WM. C., JR., Pittsfield, Mass.
MOCKRIDGE, CHESTER R., Nutley, N. J.
POPSON, S. F., Louisville, Ky.
TRUEDSSON, GOSTA R., W. Hartford, Conn.

Transfers from Student-Member to Junior, 2300

A.S.M.E. Transactions for June, 1939

THE June, 1939, issue of the Transactions of the A.S.M.E., which is the *Journal of Applied Mechanics*, contains the following papers:

TECHNICAL PAPERS

Bearing Pressures and Cracks, by H. M. Westergaard
The Forces Required for Rolling Steel Strip Under Tension, by A. Nádai
Numerical and Graphical Method of Solving Two-Dimensional Stress Problems, by H. Poritsky, H. D. Snively, and C. R. Wylie, Jr.
A Method of Calculating Energy Losses During Impact, by C. Zener and H. Feshbach
Calculation of Stresses Within the Boundary of Photoelastic Models, by R. Weller and G. H. Shortley
Creep, Elastic Hysteresis, and Damping in Bakelite Under Torsion, by Herbert Leaderman

DESIGN DATA

Vibration Problems, by J. Ormondroyd

DISCUSSION

On previously published papers by E. A. Davis; and Manfred Rauscher

BOOK REVIEWS

Necrology

THE deaths of the following members have recently been reported to the office of the Society:

BULLOCK, EDWIN R., May 19, 1939
DOWNS, EDGAR S., March, 1939
HALL, HORACE ELMER, May, 1939
HERSEE, FRED C., May 16, 1939
JEWELL, CHARLES W., May 15, 1939
KAVANAUGH, WILLIAM H., May 6, 1939
LOVELL, ALFRED, May 25, 1939
SNYDER, GEORGE T., MAY 29, 1939

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